PET Projects

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"PET", in this instance, refers to **Positron Emission Tomography**, an imaging technique; but that's not to say that we don't have some projects we're fond of. Here's one:

"Chemobrain"

Many people who undergo chemotherapy complain of losing certain mental faculties. Cancer survivors frequently refer to this cognitive dysfunction as "chemobrain" or "chemofog." Most are women who have undergone adjuvant chemotherapy for breast cancer. Typical problems are an inability to concentrate, memory dysfunction, word finding difficulties, difficulty with learning, slowed processing abilities and often difficulty with writing and speaking. A particularly disturbing complaint for many individuals is the inability to multitask.

How chemobrain is caused is uncertain; certainly chemotherapy may cause neurotoxicity and some people may be genetically predisposed to this effect, but most probably it is the result of many separate factors acting in concert.

Dr. John Hoffman, M.D. the Chief of Molecular Imaging for the University of Utah is initiating a project to examine brain anatomy, brain activity and cognitive function in women complaining of cognitive or memory dysfunction who have received adjuvant chemotherapy for the treatment of breast cancer. These patients will be compared with women with breast cancer who have undergone similar adjuvant chemotherapy for the same amount of time who have no complaints of memory dysfunction and age-matched women who have not undergone any type of chemotherapy.

To look at brain metabolism Dr. Hoffman will use **PET**. This technique involves the injection of glucose that is tagged with a very short-lived radio-isotope of fluorine (fluorine-18). Glucose fuels metabolic activity so it accumulates, and the fluorine tag with it, in parts of the brain that are active. The level and location of accumulation can then be visualized by PET imaging, giving a measure of brain function. These data will be considered in conjunction with MRI imaging and cognitive test results to identify potential areas of neurological damage.

Dr. Hoffman is not looking for a cure, but these studies may tell us why certain people suffer chemobrain and that may then point to ways of reducing or eliminating this problem. For example, if there is clear evidence that chemotherapy has caused neurological damage, then it may be possible to select chemotherapeutic agents that do not cross the blood-brain barrier (a natural barrier to the passage of toxins from the blood to the brain tissue).

Faculty news

Dr. DiBella's 2% Solution

Ed DiBella Ph.D. is a Research Associate Professor with the **Utah Center for Advanced Imaging Research**. His specialty is the development of Magnetic Resonance Imaging techniques for the diagnosis and characterization of heart disease. One approach is to inject a "dye" (contrast agent) that can be visualized by MRI, then watch as the dye perfuses the heart muscle – if it can. This technique, called dynamic contrast-enhanced MRI (dceMRI), gives useful qualitative information on heart muscle health; however, the cardiologist needs numbers: "Just how impaired *is* the blood supply?" Dr. DiBella proposed techniques to get the answers to these questions in an R01 grant application to the National Institutes of Health entitled **"Dynamic MRI for Myocardial Perfusion and Viability"**. They reviewed it and they liked it. In fact, they liked it a lot, because they ranked it in the **second percentile** of all grants reviewed by that section of NIH. Those of you familiar with the grant application review system will know that it's a rare application that ranks that high.

Dr. DiBella also proposed **"Model-Based Reconstruction for Dynamic MRI"** in which techniques will be developed to speed up the imaging process for application in procedures like dceMRI. They liked that one too. These new, rapid MR imaging techniques will be used to assess heart function, but will also find use in measuring tumor responses to therapy and the response of the brain to stimuli. Here's what it looks like to get an MRI scan (*figure courtesy of Emily DiBella, age 8*).

Radiologist Captures GERRAF!

I know... "A pun is the lowest form of humor" (unless *you* think of it first, of course).

GERRAF stands for **GE-AUR Radiology Research Academic Fellowship** which is a research grant from General Electric Healthcare Association of University Radiologists and the "captor" was **Marta Heilbrun, M.D.**, one of our new Radiology faculty.

Dr. Heilbrun came to us at the end of last year from Wake Forest University (North Carolina Baptist Hospital) in Winston-Salem where she completed her residency; but she is no stranger to Utah. After gaining a BA (*magna cum laude*) at Amherst College, Marta enrolled at the University of Utah to obtain her pre-med requirements and become a Doctor of Medicine. She then completed an internship at Stanford University Hospital and a residency in Diagnostic Radiology at Wake Forest before returning to what is really her home town. After all, her parents live here and her father, Peter Heilbrun, was the chairman of Neurosurgery at the University of Utah.

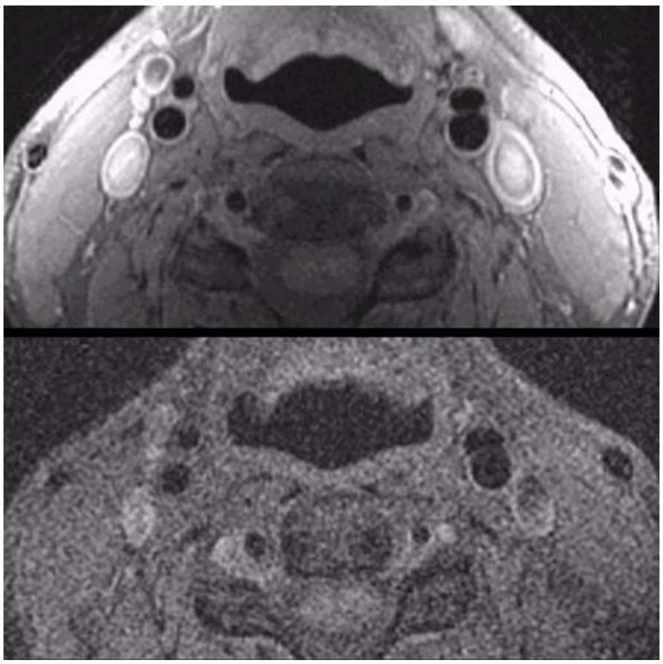
Being a radiologist is somewhat more than a full-time profession. It's always impressive then, when one of our physicians wins a research grant; and the more so when it's a first attempt by a new faculty member. The long term objective of Dr. Heilbrun's research is to create a model to evaluate how imaging-based technologies affect patient outcomes. Specifically, Marta wishes to know whether adding an image-guided biopsy to the diagnostic workup of certain kidney masses will be cost-effective by preventing patients from undergoing unnecessary treatment. It's a matter of weighing cost, in terms of patient well-being as well as hard cash, versus benefit.

Of course, winning a research grant isn't just good for the patient; it also helps Dr. Heilbrun build her status as an academic physician. So I guess it's true (you knew this was coming), it takes a GERRAF to stand taller and reach higher.

The Coil Lab

When it comes to making a better MRI scanner, there are certain things best left up to the medical industry. For example, it is just not cost effective for our investigators to build a higher field strength MRI machine when Siemens Medical Systems is in the business of making them. That's one reason why UCAIR and Siemens maintain a close collaborative relationship. On the other hand, there is a critical part of the MRI scanner that we can improve at relatively little cost: the receiver coil(s).

To make an image an MRI scanner lines up the protons in the object to be scanned, using a very powerful magnetic field, then reads the radiofrequency signal that the protons emit as they return to their former alignment. Since the nature of the signal depends on the environment of the proton (the kind of tissue it is in), then an image can be made from those signals and it is the receiver coils that detect them.

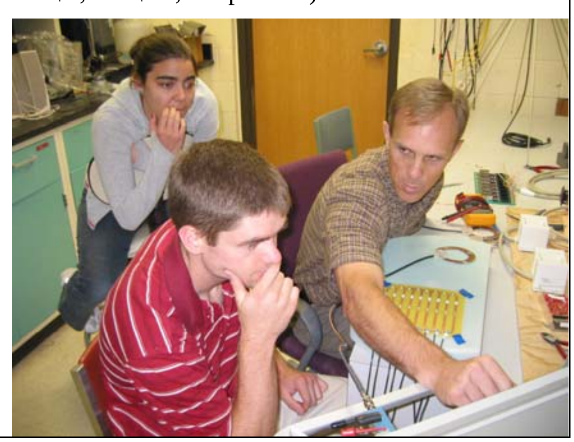


Many commercially available coils work very well; but if you want to focus on a specific structure, say the carotid bifurcation (a portion of the carotid artery in the neck where cholesterol plaque usually builds up), then a specialized coil is required. That's where our coil laboratory excels.

A receiver coil must have the right electrical properties (determined by modeling its function on a computer), be precisely placed relative to its target and, if one is good, two are probably better. Using more than one receiver coil leads to a whole set of complications however, as you might guess just by looking at the photograph of a coil set-up for imaging the optic nerve (*cover photo*). That's **Dr. John Rose** modeling a device which will help to diagnose **Multiple Sclerosis** at an earlier stage than currently possible. Each copper ring is a single coil.

To get an idea of the difference a custom-made coil set-up can make, look at these images of the neck, viewed in cross-section, from a carotid artery study (*above*). The lower image was made with a commercially available coil; the upper image was made with a coil constructed here at UCAIR. Pretty dramatic!

Few other institutions have their own dedicated coil laboratory. This is surprising when you consider the alternatives available for improving image quality. Aside from software development (our specialty), you can either buy a more powerful magnet ($3,000,000 plus for a 3T MRI scanner) or build better coils ($1,000,000 *to equip an entire lab* then $5,000-$20,000 per coil). Bear in mind that doubling the magnet field strength can roughly double the image resolution, while improving the coil efficiency may improve the resolution 5-fold! As UCAIR broadens its interests and areas of collaboration the demand for custom coils has increased. Consequently we shall be looking for funding to expand our coil lab in the very near future.



We have just 4 over-worked individuals to thank for the output of the coil lab: Rock Hadley, Ph.D., M.E.E.E., Robb Merrill, Lucine Emrazian (*right*) and Emilee Minalga. Actually, make that 3 over-worked individuals because Emilee, we are happy to report, has just given birth to a baby boy!

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The Department of RADIOLOGY and Utah Center for Advanced Imaging Research

News for Alumni and Friends

July 2007

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