FRIENDS OF AMIGO

March 2013, Issue 4

Advanced Multimodality Image Guided Operating Suite

AMIGO is a patient-friendly environment where physicians, engineers, surgeons, radiologists and nurses all work closely together

Snapshot of a Procedure: Prostate Brachytherapy

A patient was admitted to the AMIGO suite on Thursday, January 18th for treatment of a prostate tumor that was malignant and growing. Because his tumor had not metastasized, and because he was in good health otherwise, the patient would have been a candidate for traditional surgical treatment or radiation therapy. But the patient had a "j-pouch", a reservoir that is formed by folding the walls of the small intestine back onto themselves and stitching the fold to rectal tissue (a "j-pouch" is a common surgical treatment for conditions like Crohn's disease, colon polyps, or ulcerative colitis); the tumor, deemed inoperable by the surgeons because of the j-pouch, was also deemed too risky to treat with external radiation and turned out to be inaccessible by the conventional method of trans-rectal ultrasound guided radiation therapy.

With all of his other treatment options exhausted, the patient was referred to the AMIGO suite. Poring over the diagnostic images of the man's tumor, the prostate therapy team was confident that with the suite's advanced imaging capabilities, they would be able to guide delivery of radiation "seeds" directly into the tumor without the need for a trans-rectal ultrasound. This technique, which is called "brachytherapy", is a highly effective treatment for prostate cancer that traditionally relied on trans-rectal ultrasound guidance. Brigham and Women's physicians Clare Tempany, MD and Anthony D'Amico, MD introduced the use of MRI to guide prostate brachytherapy procedures two decades ago; in this case, the team would be using the suite's 3.0T MR magnet to guide delivery of the radiation "seed" directly into the tumor.

Early on the morning of January 18th, with the patient positioned on the operating table in the AMIGO suite's center room, the boulder-sized 3.0T MR magnet began its slow, steady traverse across fifteen feet of ceiling track into the center procedure room, where it locked in place over the patient. After one more, final safety check, AMIGO's Lead MRI Technologist Janice Fairhurst, RT, initiated the magnet's pulse sequences. With the whirring and knocking sounds that are familiar to anyone who has had an MRI exam, the magnet got to work. Within minutes, exquisite, detailed pictures of the patient's anatomy began populating the image queue at the computer terminal in AMIGO's control room. There, contrasted in high resolution relief contrasted against healthy surrounding tissue, was the malignancy.

Dan Kacher, M.S., the suite's lead biomedical engineer, transmitted the images to the large high-definition monitor in the procedure room where the brachytherapy team, lead by radiation oncologist Paul Nguyen, MD, radiologist Clare Tempany, MD, and physicist Robert Cormak, PhD pinpointed the exact location of the tumor. Working quickly under the bright glow from the LED surgical lights, they mapped the route for the catheters that would deliver the therapeutic radiation dose on the newest images and checked the map against the one they developed from the pre-procedure images.

Once the brachytherapy seeds were inserted into the tumor, Fairhurst re-positioned the magnet over the patient to acquire the images that the team used to assess the procedure they had just performed. Because the AMIGO suite enables this type of procedure assessment imaging while the patient is still prepped for the operation, the team would have been able to add more seeds in any locations where the deposited seeds were not producing adequate dose. After the procedure ended, the patient was resting peacefully in one of the suite's quiet recovery rooms.

This case illustrates the impact that image-guided techniques are starting to have in treating a wide range of conditions. Not only was the AMIGO prostate team able to treat this man when he had run out of options, the suite's capabilities helped them do so while mitigating the side effects and lower quality of life outcomes that are often a part of prostate cancer treatments. Intraoperative imaging also enabled the team to reduce the uncertainty associated with the procedure and help determine that it was done correctly.

More than 250 patients have been treated in AMIGO since it opened 18 months ago; the cumulative data from those cases is leading to a cautious optimism that image-guided techniques do in fact lead to better outcomes for a variety of conditions that include prostate, breast, and cervical cancer, atrial fibrillation, and brain tumors. Though it's too early to draw any sweeping conclusions, encouraging trends are emerging: faster recovery times, reduced hospital stays, and improved quality-of-life following treatment are some of the benefits from image-guided therapy. It will take time for experts from clinical care, healthcare economics, and hospital administration to process the data coming from the AMIGO suite's clinical programs and use it to manage the extent to which other healthcare systems should build their own image guided therapy programs.

For patients like the gentleman treated on January 18th, the potential for image guided techniques to become the standard of care practiced at more hospitals could also be the source of hope in uncertain situations.

Catching Up with Junichi Tokuda, PhD

Junichi Tokudo, PhD, software developer with AMIGO's MRI-guided prostate biopsy program

Junichi Tokuda, PhD joined the Image-Guided Therapy Program at the Brigham in April 2007 and has been integral to its prostate cancer research. An Instructor in Radiology at the BWH and Harvard Medical School, Dr. Tokuda first received a BS in Engineering in 2002, an MS in Information Science and Technology in 2004, and a PhD in Information Science and Technology in 2007, from the University of Tokyo, Japan. His research interests include navigation software, MRI-compatible robots, and integration of these technologies for the operating room. He has been working on these topics since 2001, and has broad experience developing software and devices for these applications. For example, software that he developed at the Shiga University of Medical Science, Japan, was then used to assist in MRI-guided microwave coagulation therapy of liver tumors. Dr. Tokuda has been the lead author on a number of articles that have been published in journals like International Journal of Computer Assisted Radiological Surgery and Physics Medicine Biology.

The following Q&A profile shows what a friend to the BWH and the AMIGO Dr. Tokuda truly is.

What is your role in the prostate program in the AMIGO?
My role is to develop software for MRI-guided prostate biopsy in AMIGO.My primary focus is work involving how to precisely guide the biopsy needle to the target.

I developed planning software that calculates a needle insertion path based on position of the region identified on the fused MRI. The calculated needle path is translated to a needle insertion depth and a hole index on a grid template, which is placed in front of the patient's perineum. The clinician inserts the needle through the specified hole with the specified depth. My work is integrated into the medical image computing software, which is called the 3D Slicer, used in the AMIGO.

Are you present during cases? What is this experience like? What has surprised and/or challenged you?
Yes, I am present during cases. It is always exciting to see how our technologies are being used in real patient care.

Of course we often end up learning our product does not work as expected. For example, no matter how accurate our software is, the needle often deviates from its intended path during insertion because of various factors such as unexpected patient motion, needle bending, and error in localization of the template. But by working together with the team of medical doctors, nurses, and technologists in the AMIGO, we can share such issues and discuss possible solutions. I think this is a crucial part of my research.

Another important aspect of being present during clinical cases is to develop a good relationship with the nurses and the technologists on site. Without their help, we can never test new technologies clinically. I think that trying something new while maintaining patient safety is always a big challenge for them, and they wouldn't be comfortable to work with someone whom they don't really know. Fortunately, the staff in the AMIGO is always generous and supportive.

How many cases have you been involved with?
There have been more than 40 prostate biopsy cases in AMIGO. I attended about half of them.

What are you working on now?
With Drs. Sang-Eun (Sam) Song, PhD and Nobuhiko Hata, PhD we are developing a motorized needle-guiding device that will replace the current needle-guiding template. The device is connected to our planning software via a network so that it can instantly align the needle with the planned path. We hope the device will improve needle placement accuracy as well as reduce procedural time. I am mainly in charge of electrical system and control software, while Sam is in charge of mechanical design. We have been working closely with clinicians Drs. Clare Tempany and Kemal Tuncali to adapt the device for clinical workflow. Recently we started using the device in clinical cases.

What importance does the AMIGO have for prostate research and care in general?
The state-of-the-art 3T MRI scanner allows us to obtain a clear image of the prostate during the procedure and provides a precise map of the prostate. This capability could lead to a better cancer detection rate than transrectal ultrasound-guided biopsy (TRUS), which is the current clinical standard. Another importance is AMIGO's flexibility in its choice of intraprocedural imaging modalities, room layout, and computing. These qualities are important when we design a new clinical workflow that incorporates new technologies.

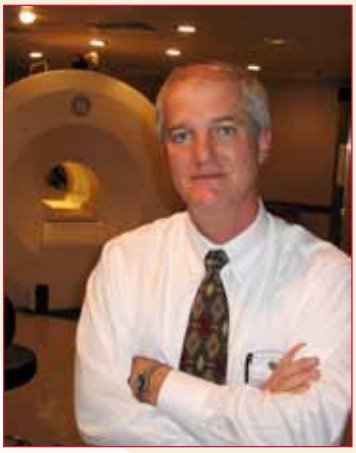
What do you see as "innovative" in medicine or science right now and why?
The iPS cell. I had a chance to read Dr. Shinya Yamanaka's paper more than a year ago, and was quite impressed by the idea of reprogramming a somatic cell and his and his colleagues approach to identifying four transcription factors that induces pluripotency. It is not directly related to my research, but we should keep an eye on the progress in that area to see how it affects the role of radiology in the future.

What town/city did you grow up in Japan, and what was it like?
I grew up in Yokohama and Tokyo. Both located in the Greater Tokyo area. Tokyo is a huge city with many unique districts/areas. There are upscale areas, trendy areas for young people, areas for teens, areas for nerds and techies, such as myself, with a lot of electronics stores, area with book stores. I really enjoyed living there. When I am there, I am never been bored.

Are you married? Tell me about your personal life?
I got married in January 2012. Her name is Yuka. We met in the Brigham, where she was working as a research fellow.

My current interest is cooking. I mostly do Japanese, Chinese and Italian. I have a big steel wok and a pasta machine in my kitchen.

In Memoriam: Paul Morrison, MS



The AMIGO team mourned the loss of talented, beloved colleague Paul Morrison, MS, who died on September 24th after battling cancer. A medical physicist who worked at Brigham and Women's Hospital for the past 20 years, Paul had been with the Image Guided Therapy and AMIGO teams for the past decade. Colleagues described their admiration for his kind, thoughtful demeanor and devotion to his family, friends, and co-workers.

"So much of what we do as care providers springs from the trust and camaraderie we feel towards one another," said Angela Kanan, RN, nurse-in-charge for the AMIGO suite. "Paul was the total embodiment of that. He was hard-working, smart, reliable, and a great teacher. The warm respect he had for everyone he worked with was the source of much of that camaraderie we have in the AMIGO team."

A Boston-area resident for much of his life, Paul grew up in Dorchester and attended Holy Cross College. After college, he entered the graduate program in Physics at the Illinois Institute of Technology, earning his MS degree in 1987. Paul then returned to Massachusetts to begin his career and start a family with his wife, Gina, with whom he had a son, Nicholas. He joined Brigham and Women's Hospital in the early 90s, working on applications of laser technology in otolaryngology with the Department of Surgery.

It was while at BWH that Paul's career started to excel. His expanding research into the therapeutic possibilities of lasers coincided with the introduction of the first generation of Image Guided Therapy techniques. His experiments in MR imaging of thermal events showed the promise of this method in minimally invasive treatment of tumors throughout the body. In 2000, Paul transitioned from the Department of Surgery to the Department of Radiology, where his expertise in clinical applications of laser technology and MRI thermal imaging were a vital addition to the department's interventional radiology programs and services.

Paul went on to be involved in more than 1,000 cryotherapy, radiofrequency and laser ablative procedures, including the first ablation of a kidney tumor under 3.0T MRI guidance in the United States, along with other cryo, laser, and RF ablations that were first performed at Brigham and Women's Hospital.

In the early 2000s, Paul was asked to participate in planning the equipment array for the AMIGO suite. His familiarity with the wide variety of coils, probes, silicon chips, applicators and other accessories for MR thermal imaging and laser treatments enabled detailed reviews of dozens of instruments. It was through these exhaustive reviews, which took place for not only each piece of equipment but also elements of the architectural design, that the team was able to "future proof" the AMIGO suite and guard, as best as possible, against obsolescence.

Amidst the AMIGO suite planning process and his ongoing role in the ablation program, Paul continued with his research work and teaching responsibilities. He co-authored more than 35 papers and gave presentations at BWH, the Radiological Society of North America, and the American Association of Physicists in Medicine, of which he was a longstanding member.

Paul was excited by the potentials of the technology he worked to develop but he always remained humble to the fact that, fundamentally, these devices were tools for improving the lives of patients and their loved ones.

"Paul worked with me from the very beginning of our Image Guided Therapy Program. He was a very modest person, but indispensible and his contributions to both clinical and research projects were essential," said AMIGO co-medical Director Ferenc A. Jolesz, MD. "Now that he is no longer with us, we recognize even more how important his role was in our programs. He was never in the driver's seat but he was the one who energized all of us. We will miss him as a colleague, friend, and a unique person whose full devotion to his work was motivated by conviction and a commitment to patient care and science"

Paul's colleagues in the Department of Radiology established a fund to provide assistance to his family. Please contact Angela Kanan at akanan@partners.org or Tina Kapur at tkapur@bwh.harvard.edu for information about donating.

Another Milestone for AMIGO: Treating the Suite's 250th Patient

The AMIGO team achieved another milestone when Kemal Tuncali, MD, and the tumor ablation team he leads performed the 250th procedure in the suite on January 31st, 2013. This latest milestone happened six short months after the 100th patient was treated.

"I was very happy to receive the news of the 250th patient procedure in AMIGO," said Clare Tempany, MD, the suite's co-Medical Director. "This milestone is a great achievement for the team and speaks to the hard work of everyone involved in the day-to-day operations of the suite's clinical programs."

Congratulations to the AMIGO team for achieving this milestone!

Researchers Develop New Tool to Help Brain Surgeons in Operating Room

From left, Nathalie Agar, Isaiah Norton, Alexandra Golby and Sandro Santagata comprise the BWH DESI spectrometry team

Distinguishing the border between normal and cancerous brain areas can often be difficult for surgeons attempting to remove tumors. But a new tool may change this, allowing more comprehensive testing of brain tissue during surgery to help surgeons quickly make the call between healthy and cancerous tissue.

So far, the tool has successfully identified the cancer type, severity and tumor margins from tissue samples of five brain surgery patients, according to a new study conducted by researchers from BWH's departments of Neurosurgery, Radiology and Pathology, and Purdue University.

"Tumor tissue within the brain often closely resembles normal brain tissue and may have indistinct boundaries, so it is difficult to determine where tumors end and normal brain tissue begins," said co-study author Alexandra Golby, MD, director of Image-Guided Neurosurgery in BWH's Department of Neurosurgery, and clinical co-director of BWH's Advanced Multi-Modality Image Guided Operating (AMIGO) suite.

"During surgery, we want to preserve as much functional brain tissue as possible, especially when a tumor is in a critical area of the brain, such as those that support movement, speaking or vision."

Today's surgical methods rely on a surgeon's trained eye along with the help of an operating microscope and brain image scans taken before or during surgery.

According to co-study author Sandro Santagata, MD, PhD, of BWH's Department of Pathology, examining frozen brain tissue specimens (which are transferred from the operating room to a pathology laboratory) takes about half an hour—a long time to wait during surgery. This problem is magnified when surgeons need information from multiple samples during the course of a procedure.

A tool in the works

Attempting to develop a tool that would allow surgeons to address the time delay that occurs during tissue analysis, researchers tested an imaging tool known as "desorption electrospray ionization" (DESI) mass spectrometry.

DESI mass spectrometry was initially developed by researchers at Purdue University. The BWH research team initiated a collaboration with Purdue University to use this technology to test brain tissue samples from patients who underwent surgery in the AMIGO suite and in standard BWH operating rooms.

In the study, surgeons removed 32 specimens from patients during surgery, which were later analyzed by both the new tool and standard pathology methods to test for accuracy. The researchers used DESI mass spectrometry to evaluate the distribution and amounts of fatty substances, called lipids, within the brain tissue specimens. A software program developed by the team then used the results to characterize the brain tumors and detect boundaries between healthy and cancerous tissue.

"The new tool is able, in a matter of seconds, to identify and classify many types of brain tumors, and to recognize tumors that are likely to behave aggressively," said Santagata. "Accessing this type of information at a pace that is more compatible with the pace of surgery could be a big plus for patient care."

Next Steps

The researchers plan to improve the classification software. BWH has set up DESI mass spectrometry technology in the AMIGO suite and plans to test it to detect brain and breast cancer margins during surgery.

"This approach could lead to real-time, image-guided surgery," said Nathalie Agar, PhD, director of the Surgical Molecular Imaging Laboratory in BWH's Departments of Neurosurgery and Radiology, and co-lead study author. "Such extensive and detailed information about brain tissue that could lead to more precise tumor removal was previously unavailable to surgeons. In addition, having access to a detailed diagnosis on the day of surgery could help an oncologist more efficiently design the course of post-surgery therapy."

The preceding article originally appeared in the February 1, 2013 edition of the BWH Bulletin