Fall 2010

JOHNS HOPKINS MEDICINE

RADIOLOGY report

a publication for friends and colleagues of the Russell H. Morgan Department of Radiology and Radiological Science

The New Baby Has Arrived

The "baby" of the scanner family in the Department of Radiology has arrived. The 7T MRI scanner, the result of a joint effort of the F.M. Kirby Foundation, the Kennedy Krieger Institute, the NIH (in the form of an NCRR instrumentation grant to Dr. Peter van Zijl), Philips Healthcare, the Brain Science Institute (BSI) and the Department of Radiology, is now officially up and running in a new building of the Kennedy Krieger Institute (KKI) on the East Baltimore campus. The building is located directly across Broadway from the Johns Hopkins Broadway Research Building, between the Metro station entrance and Madison Street.

MPRAGE, 0.5x0.5x0.5mm, TR 5.6, TE 2.5, scan time 6 min 11 sec

Weighing in at 35 tons, the delivery of this "baby" was quite a project. As Joe Gillen, a Research Associate in the Division of MR Research explained, "The 7T has a certain 'footprint,' and required extra special design and engineering considerations." For example, the magnet is not self-shielding, which necessitated a 440-ton steel box around the magnet. The box had to be designed so that the magnet would sit perfectly in the center to balance the forces of the magnet on the 16-inch thick steel walls. Another consideration was the proximity of the Metro. "Measurements indicated that the vibrations from the Metro trains could be a problem, so we decided that we would need air cushions vibration isolation for this magnet," Mr. Gillen explained. The entire MR examination room, including the 440-ton shield with its infill, the 35-ton magnet, and all exam room interior finishes are suspended on a Hammond Kinetics air spring isolation system. Twenty-six pressurized air springs lift the room approximately 1/4 inch, providing complete isolation from outside vibrations. Three level sensors regulate the air pressure in the air springs to keep the room level. Because of these issues and other design requirements, the problem of where to place the magnet was a little thorny.

"There were already two 3T scanners in KKI, and there would have been enough space for the 7T, but the building supports would not have accommodated this scanner without modifications. KKI was in the process of building the new Clinical Research Building anyway, and space was designated for the magnet. But, it meant that the cost of the building nearly doubled, and not only because extra pilings [75 feet down] were required to support the magnet," said Mr. Gillen. Including the 7T scanner in the project required adding a process chiller to produce cold water for the magnet's cryogenic coolers and scanner hardware, dedicated air conditioners for the scan and equipment rooms, a 300 kVA uninterruptable power system, the vibration isolation, and lots of extra excavation and concrete to expand the basement to have the required 24 foot vertical clearance needed for the shield room.

MP-FLAIR, 1x1x1 mm, TR 8000, TE 300, scan time 8 min 8 sec

The magnet is a dedicated research instrument,

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Chairman's Corner

The approach of Fall and the beginning of another academic year is a good time to reflect on what has been accomplished, and to consider where we are going as a department. Some of the

biggest changes, often not very visible on a quick walk around the department, are changes in infrastructure. These types of improvements have been particularly important over the last six years, and have included significant upgrades to both our research and clinical infrastructure. During that time, we have installed or replaced three research MRI scanners in our main hospital complex. One of these systems links a short gantry 1.5 T MR system with a high-end digital angiography system for advanced interventional research and clinical procedures. These can be performed under MR alone, X-ray alone, or using fusion images of MR, X-ray fluoroscopy, and cone-beam CT, all in the same imaging room. We have also upgraded the 1.5T system to 3T and have installed an additional MR scanner, a 7 Tesla machine, at the Kennedy Krieger Institute. The 7T scanner at KKI, a whole body system that can be used for neuroimaging as well as other applications, promises to be an exciting opportunity for research and discovery. You can read about some of the technology involved in coordinating and installing this system in this issue of the newsletter. In addition, this time period saw the establishment of a new research digital angiography system in our animal lab, and further development of our many small animal imaging systems. Our PET research infrastructure also saw major advances, with installation of our second PET-CT and with placement of one of the few high-resolution brain PET systems in the world.

The reorganization of the research administration infrastructure has been completed and RORA (Research Office of Radiology Administration) is now fully staffed, and is quite a bit more efficient in the handling of grant applications and budgets. The staff of RORA has been working diligently to help investigators and their administrative assistants adjust to the new changes in grant application processes at the NIH, and has been helping to manage the strict reporting guidelines for the almost $20,000,000 in stimulus funding that our faculty have received through the American Recovery and Reinvestment Act.

Clinically, between this campus and Bayview, we have seen a significant renewal of clinical equipment over the last six years. This includes an almost entirely new fleet of scanners in CT and MRI, many new nuclear cameras, ultrasound systems, angio rooms, and ultrasound equipment. Indeed, also in this issue of the newsletter, be sure to read the story about the CT scanner on rails at the Bayview campus. The clinical improvements have been necessary to keep us on the cutting edge, and to keep up with our growing clinical volumes: over the last six years, we have grown from 680,000 RVUs per year to approximately 955,000 RVUs, or 800,000 exams per year across the department. I am confident that the clinical and research infrastructure revitalization we have enjoyed will serve us well, and long into the future.

—Jonathan Lewin, M.D.

New 7T Baby —continued from page 1

managed by the F. M. Kirby Research Center. Mr. Gillen went on to say that, although there are still many technical difficulties associated with the 7T, there should be many advantages that will eventually translate into clinically relevant advancements. "Not only is the 7T less noisy than a 3T scanner, but the resolution for orthopedic pathologies is far better, as well as for functional brain imaging," said Mr. Gillen. In fact, he noted that the 7T uses the same interface as current clinical applications, and that some MS [Multiple Sclerosis] studies are now being conducted on the new scanner.

In addition, the Brain Science Institute (BSI) has funded 10 projects to acquire pilot data at 7 Tesla, which should optimize the protocols for these projects and allow data for NIH grant applications to be acquired. The projects include several from investigators in Radiology, namely by Drs. Alena Horska (brain energetics), Doris Lin (AVM patients), Peter Barker (epilepsy), Jay Pillai (brain tumors), and Bruce Wasserman (intracranial vessel imaging). Other departments funded are Neurology (Daniel Harrison for spinal cord imaging in MS and David Zee for eye movements in the scanner) and Sarah Ying (dentate nucleus degeneration in ataxia), psychiatry (Pamela Mahon, bipolar disorder; Chris Ross, Huntington's Disease; Gwenn Smith, geriatric depression), and Kennedy Krieger Institute (Mark Mahone, ADHD). In addition, an initial study on 50 Alzheimer's patients and MS patients is funded through a supplement to the P41 resource grant of Dr. Peter van Zijl. The U.S. Army has funded a traumatic brain injury prevention study by Dr. Robert Stevens (Anesthesiology). There are also some 3T protocols that have been translated for use on the 7T scanner.

"While we have a few technical barriers to overcome, we believe the 7T will provide superior image resolution, and allow us to visualize things we couldn't see with the 3T scanner," noted Mr. Gillen. And, the 7T scanner is truly a part of the "family" of scanners in Radiology and KKI, as it is available for on-line scheduling with all the other existing scanners. Any investigator can access the scanning schedule and even get help with designing a protocol.

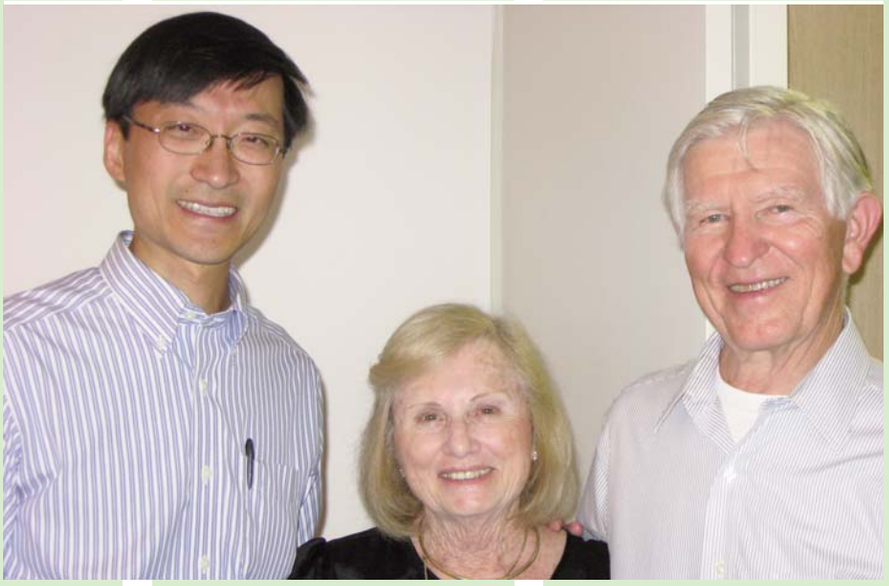
Welcome to the newest member of the scanner family!

The Quest for Knowledge

Walter F. Ciceric, M.D., grew up in Portland, Oregon. After receiving his bachelor's degree from the University of Portland, he considered pursuing a Ph.D. in physics, but those plans were altered by a brief encounter with a radiologist in town who needed his x-ray machine calibrated. Walter Ciceric agreed to assist the local doctor with this task, and was intrigued by what he learned about the radiology profession. This experience changed the course of his life. He decided to become a radiologist, and took the advice of an academic advisor at the University of Portland that he apply to The Johns Hopkins University School of Medicine. Dr. Ciceric turned down an offer from the University of Oregon Medical School and became one of the few graduates from the University of Portland to attend Johns Hopkins University. Once enrolled in medical school, he discovered that he was one of only a handful of classmates who already knew the area of medicine he wished to pursue.

His family moved to Baltimore with him, where they lived in the compound on the East Baltimore Medical campus. Dr. Ciceric met his wife, Mary, during a church social event when they were in the eighth grade. They married after both completed their undergraduate educations. Their daughter Gale was born in Oregon in 1955—the year before the family moved to Baltimore.

Dr. Ciceric received his medical degree from Johns Hopkins in 1960, completed an internship at the King County Hospital in Seattle, Washington, in 1961, and returned to Johns Hopkins for his residency from 1961 to 1963, followed by a fellowship in 1964. During his training, Dr. Ciceric worked closely with Russell H. Morgan, M.D., who was Chairman of the Department of Radiology at that time.



Dr. Ken Wang, Mary Ciceric, and Dr. Walter Ciceric.

Prior to the 1960s, in order to work with a fluoroscopic screen, radiologists needed to wear red goggles to help their eyes adjust to low light levels. After removing the goggles, the radiologist could work on the patient in the dark fluoroscopy room. Dr. Morgan determined that it was possible to acquire the image from the screen by using a television camera, which made it possible to electronically amplify the image and display it on a television screen so it could be seen in daylight. Dr. Ciceric assisted Dr. Morgan with the design of this new technology, working with him to manually wire this new device in the basement of the Brady Building on the East Baltimore medical campus. This technology—a major advancement designed to improve resolution and enable radiologists to work in daylight—is used today in many areas throughout medicine.

In 1965, Dr. Ciceric joined the radiology staff at Memorial Hospital in Easton, Maryland, and spent one day a week at Johns Hopkins training residents. In 1970, the family moved to Florida, where Dr. Ciceric joined the radiology staff at Broward General Medical Center in Fort Lauderdale. Two years later, he helped to open the new Imperial Point Hospital in Fort Lauderdale, where he served as Chief of Radiology. The Imperial Point Hospital is part of the North Broward Hospital System, the fifth largest hospital system in the United States. Dr. Ciceric became the Chief Radiologist of this district and retired in 1998.

The Cicerics value their relationship with Johns Hopkins, and wanted to find a way to give back to help the next generation of trainees in the Russell H. Morgan Department of Radiology and Radiological Science. As a result, they established The Walter and Mary Ciceric Research Fund in the Department of Radiology, an endowment that provides research support for a fellow or junior faculty member. Kenneth C. Wang, M.D., Ph.D., the first Walter and Mary Ciceric Research Award recipient, is developing next-generation MRI techniques for peripheral nerve imaging in collaboration with other members of the department's musculoskeletal imaging section. This work involves developing scanner protocols, elucidating the imaging characteristics of peripheral nerve anatomy and disease, and initiating collaborations between radiologists, surgeons, and neurologists. Dr. Wang commented, "This award was an important part of my research during the past year. I am grateful to the Cicerics whose support enabled me to present my work at professional meetings and to interact with other researchers conducting similar work at other institutions. After meeting Dr. Ciceric, this award is even

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What is the Meaning of [Child] Life?

In the Department of Radiology, the meaning of "child life" can be explained by Amanda Moatz, a Certified Child Life Specialist.

"Our job is to support children and families who may be under considerable stress about the medical procedures they will undergo. So, our job might include teaching and preparation of families, or explaining to a child what his/her role is in the procedure. Or it might include making the hospital waiting room a friendlier, less threatening place by including toys and making the atmosphere more kid-friendly," explained Ms. Moatz.

Amanda Moatz, Child Life Specialist

Although child life activities are different in every hospital department, in Radiology, specifically, Ms. Moatz will focus on "fluoroscopy and MRI." In fact, Johns Hopkins was one of the first child life programs. Ms. Moatz noted that "Last year, we celebrated the 65th anniversary of the establishment of the Child Life Program, and there are now about 4,000 Certified Child Life Specialists across the country."

"Child life programs derive from the days when pediatrics was a big, open hall of kids and there were no appropriate developmental activities. A group of women would come in to play with the kids, which was really the beginning of a formalized child life program," said Ms. Moatz. She went on to explain that "although some people might think that play is not important, play is actually the 'work' of childhood. Play is the basis for learning, it can help process a difficult diagnosis, and help patients gain back a little of the control lost when they're admitted to the hospital." Ms. Moatz cited the fact that studies have shown that Certified Child Life Specialists are not only beneficial for families in reducing the potential stress of a hospital encounter, but also have the ability to reduce the number of children who need anesthesia or sedation to undergo a procedure.

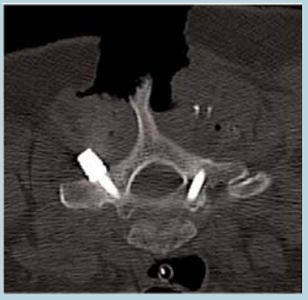
"We were granted funds from the Radiothon Special Project Fund grant to develop and manage an MRI tour program. Patients between the ages of 5 and 10 years old, who are scheduled for general anesthesia, will be offered a tour of the MRI suite before the procedure. This will include medical play with blank cloth dolls and a wooden scanner, watching a video about an MRI, and actual practice time in the scanner. Dr. Thierry Huisman, Chief of Pediatric Radiology, is very supportive of the Child Life program, and agrees with Ms. Moatz that their goal is to "build up the pediatric services we offer now [which includes having a Child Life specialist on staff], so that when we move into the new building in January of 2012, we will have referral procedures and other protocols down to a science."

Although Ms. Moatz is now only part-time in Radiology (she spends 3 days/week in Urology), everyone recognizes the need for Child Life as a full-time official service, and, by next July, Radiology will provide funding for a full-time child life specialist position. She adds that "child life is not a billable service, so we provide this free of charge to patients. Radiology is one of the areas where child life services has been able to prove its worth. "

Ms. Moatz has met with several physicians in neurology and neurosurgery to explain what the MRI tour will provide for patients and families, and is working to develop efficient and effective means of referral and tour programming. Ms. Moatz has a B.S. in human development and family studies and a Master's in health education. Originally from Hershey, Pennsylvania, she had wanted to become a pediatrician, but had volunteered with the Child Life program at Penn State Hershey Children's Hospital during high school, and knew that it was really the "best mix of what I wanted to do – working with kids in the healthcare setting." After completing her child life internship at the Children's Hospital of Philadelphia, Ms. Moatz worked as a child life specialist in Pediatric Radiology and Radiation Oncology at Penn State Hershey Children's Hospital. In 2008, Ms. Moatz left her position as Child Life Coordinator at PSHCH to move to Baltimore and begin work here at Johns Hopkins Children's Center. As she said, "It was quite a transition from central Pennsylvania to Baltimore, but we really like it," and, most of all, she is looking forward to establishing a Child Life program in pediatric radiology that meets the needs of patients, families, and referring physicians.

Riding the Rails...

"Riding the rails" has taken on a whole new meaning at Bayview. Dr. Mark Bohlman is the Chairman and Director of Cross-Sectional Imaging at Bayview, where there is a CT scanner that moves on rails, and provides new opportunities for precise



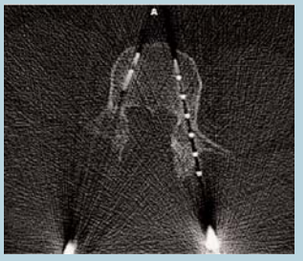
Excellent intra-operative CT-guided placement of fixation screws during a cervical spine fusion surgery.

imaging in an operating room setting.

"The scanner is actually positioned between two operating rooms, and it's a phenomenal tool for neurosurgery and spine surgery," he explained. The scanner is the first of its kind in the country, and it's a Siemens high-resolution, 40-slice CT scanner, which uses Brain Lab hard- and soft-ware. The installation

Less desirable position of temporary probe during surgery can be promptly demonstrated to avoid further placement of hardware. This can be done before the patient leaves the operating room, eliminating the possibility of complications.

and management of the scanner represents a joint effort between Radiology and Neurosurgery. "We can render the spine in space, and a "line" in space guides the placement of pedicle screws, for example. We can put a wire directly on the path of this line," Dr. Bohlman said. He went on to add that "this not only increases the accuracy of placement, but also helps surgeons to determine exactly where to dissect. If there's a mistake, it can be corrected immediately. This is a new way to use localizers in 3D space." Dr. Bohlman explained that, previously, it was sometimes difficult for surgeons to determine where to operate because, with the



Excellent intra-operative CT-guided placement of fixation screws during a lumbar spine fusion surgery.

patient draped, there were no visible landmarks.

"This is much safer for the patient, and can be performed more rapidly. This allows us to do things we couldn't do before," he said, citing the example of an intraoperative aneurysm, which required a C-arm angiogram, a catheter to check for leaks, and radiation to the whole body. "With this machine, we can do a CTA, without the need for a neurointerventionalist, and the radiation exposure is limited to the head," he explained.

Dr. Gary Gong, an Assistant Professor of Radiology at Bayview, who kindly provided the images accompanying this article, said that, "we are only just scratching the surface regarding the uses for this machine. In addi-

Dr. Mark Bohlman with one of his prize catches.

tion to brain surgery, this could be used for pelvic tumors and fibroid ablation."

Dr. Bohlman said that they are doing about ten cases per week, and he expects that to increase rather quickly. "This is especially beneficial for elderly patients, and also for people who might be overweight. We can pass through layers of tissue and still get great images," he said.

Dr. Bohlman has been at Bayview since 1980, where he "planned on spending one year, and I'm still here." It's clear that he enjoys his work, almost as much as he enjoys fishing in his spare time.

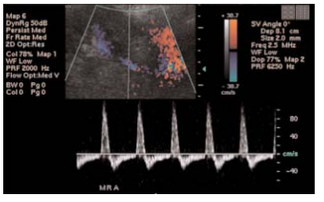
Case of the Quarter

We're introducing a new column in this newsletter, the "Case of the Quarter," taken from among the interesting clinical cases during the past quarter. The answer to the case "quiz" will appear on another page of the newsletter. Test your skills!

A 54-year-old woman underwent cadaveric renal transplant a week prior to the MRA below. Patient had significant pain over the allograft in the right lower quadrant.

The Color Doppler of the main renal transplant artery and the arcuate artery in the mid kidney showed a reversal of diastolic flow.

Maximum intensity projection (MIP) MR angiography



Doppler showing reversal of diastolic flow

What is the diagnosis?

A. Arterio-venous fistula
B. Arterial thrombosis
C. High-grade arterial stenosis
D. Renal vein thrombosis

Quest—continued from page 3

more meaningful to me since I feel that we have a personal connection because of our similar backgrounds and our shared interests in technology and medicine."

According to Dr. Ciceric, "There is no better way to allocate one's assets than to give back to supporting important medical research projects. I highly value my experience at Johns Hopkins and appreciate the opportunity to help the next generation of radiologists."

An interest in science and medicine has filtered down through the Ciceric family. In the summer of 2010, Alexandra Payne, the Cicerics' granddaughter, volunteered to work in the laboratory of Kristine Glunde, Ph.D. This laboratory is part of the Cancer Molecular Imaging Program overseen by Zaver M. Bhujwalla, Ph.D., in the Russell H. Morgan Department of Radiology and Radiological Science. Ms. Payne's research project was to characterize changes in phospholipase C in cancer cells, in order to further understand the causes underlying the increased total choline observed in cancer. High total choline levels are being evaluated as a radiological diagnostic marker of cancer. Ms. Payne, whose family lives in Fort Lauderdale, is a senior in high school and is interested in pursuing biomedical engineering.

Walter and Mary Ciceric enjoy a bi-coastal life, maintaining homes in Florida and Oregon, and pursuing their passion for boating and fishing. In June 2011, Walter will return to Baltimore to celebrate his 50th class reunion at The Johns Hopkins School of Medicine. He proudly says, "Every time I return to Johns Hopkins for a reunion, the one thing that resonates among my classmates and me is our great appreciation for the valuable education and training that we received during our years at Johns Hopkins."

This appreciation is now being passed on to future generations.

RSNA Update

This year's RSNA alumni reception, hosted by the Russell H. Morgan Department of Radiology and Radiological Science, will be held at the Palmer House Hilton, Empire Room, 17 East Monroe Street, Chicago, Illinois, from 6:30 p.m. to 8:30 p.m., on Tuesday, November 30, 2010.

Radiology History Remembered...

Did you know?

1. Hopkins and University of Maryland radiology have had connections for many years.
   - John Pierson, the second chairman at Hopkins was a University of Maryland School of Medicine graduate.
   - Hopkins and the University of Maryland shared responsibility for Baltimore City Hospitals radiology with direct involvement and consultation from the 1920s until 1980.
   - University of Maryland radiation therapists worked directly at Hopkins in the 1950s, doing patient care and teaching

2. Sinai Hospital was located immediately north of Monument Street between Broadway and Wolfe Street until the 1960s.

3. The photograph to the right of Dr. Martin Donner in his oil painting is of Curt Richter, good friend and mentor of Dr. Donner. Richter is considered the father of the "biological clock" concept.

4. Thirty American medical schools, and counting , have had radiology chairmen who either trained here or were on the faculty at Hopkins.

5. Three medical school deans have Hopkins radiology connections: Russell Morgan, Johns Hopkins; Martin Silbiger, University of South Florida; and Phil Alderson, St. Louis University.

What About That New Space?

Where does Radiology fit into the new Sheik-Zayed Tower and the Bloomberg Children's Hospital, scheduled to open in early 2012?

Dr. Bob Gayler has some answers. He explained the background for the new facility and Radiology's plans for space there. "The impetus for the new facility began in the mid-1980s, at the same time we were planning for the Johns Hopkins Outpatient Center. There were significant patient needs that were not being met in existing space in the Children's Medical and Surgical Center, or in the operating rooms that were in the adult medical and surgical buildings, Osler and Halsted," he said.

The initial plan was to move ahead fairly quickly after the opening of the Outpatient Center. However, priorities changed with available funds, and the Kimmel Cancer Center in the Weinberg Building moved ahead of the Children's Hospital and the new adult hospital. Consequently, serious planning for the new clinical buildings started early after the opening of the Weinberg Building in 2000. "There were detailed studies of where inpatient healthcare was moving with respect to the regulatory environment, length of stay, changes in surgery, and Maryland and mid-Atlantic demographic trends. Radiology was involved from the beginning and our job was to look at what clinical operations were going to be in the new construction and to see where these were to be located. We wanted to combine patient convenience and safety with operational efficiencies as much as possible. In any large project, there are many factors to be considered, and the larger the geography, the more complex the planning becomes," Dr. Gayler explained.

Artist's panoramic rendering of the new building.

In the new building, pediatric and adult emergency departments will be on the same level, which is on the street level of the side of the building, facing Orleans Street. Since the pediatric emergency department and adult emergency department are immediately adjacent to each other, Dr. Gayler said that "it made sense to centralize imaging." This was done, with one exception. There will be a routine radiographic room, centrally located within the pediatric emergency department for extremities and chest radiography. The centralized imaging area will include two computed tomographic units, two radiographic rooms, one magnetic resonance imaging room, one ultrasound room, and basic x-ray equipment in six trauma spaces. In addition, there will be one mobile radiographic unit, which can be used as appropriate following line placement and chest tube placement, as needed. The adult emergency area will have a direct corridor linked to the basement level of the Nelson building, where radiology will maintain a presence for adult radiography and fluoroscopy, and for inpatient nuclear medicine examinations.

The 3rd floor of the new building will house neurosurgical and orthopedic surgery and recovery areas, with the neurological intensive care unit. Neuroradiology and interventional radiology will be adjacent on the 3rd floor, with two biplane angiographic rooms, six single-plane angiographic rooms, and two computed tomographic units, primarily to be used for interventional procedures with CT guidance. One of the biplane rooms and one of the single-plane angiographic rooms will be contiguous to an MRI unit, so that sequential catheter exams and MR imaging can be done. In the operating room suite, there will be an MRI unit that can be physically moved on very heavy-duty rails into two different operating suites, for assessment of patients in immediate relationship to surgical procedures. Down the hall, there will be a diagnostic CT unit for rapid and safe assessment of patients in the neurological intensive care units.

On the 4th floor, there will be seven ultrasound rooms, three of which are specifically designed for ultrasound-guided biopsy procedures. There will be a ten-unit recovery and prep area, centrally located. There will be three CT units when the building opens, one physically in the pediatric radiology section, with space for a fourth CT unit around the corner. There are four MRI bays, with one to be held empty at the time the building opens. This will be filled later, depending on volume. The pediatric radiology imaging area will include one direct digital radiographic unit, one fluoroscopic room, the above-mentioned CT unit, and two ultrasound rooms. One of the MR units, which is on the same level and down the

(continued on page 8)

New Space—continued from page 7

hall, will be set up with features to enhance the pediatric experience. All together, there will be 45 designated imaging rooms, with 155 support rooms. The net radiology footprint will be slightly more than 38,000 square feet. "We will have the largest square footage on the 4th floor," said Dr. Gayler, "which is almost twice as much as we now have for peds, adult, ultrasound, and neuro in Nelson."

Interventional radiology will move entirely out of the Children's Center building. The MRI building will gradually transition to primarily research functions. The neuroradiology space in the Radiology Building and the ultrasound base in the Halsted Building will be transition areas, while some clinical operations will continue in this space. Nuclear medicine will expand to fill a portion of the space vacated by pediatric radiology in the Nelson basement. Adult radiography and fluoroscopy will continue in the present locations. Outpatient Center operations are not expected to significantly change.

All these changes required a significant amount of planning, and Dr. Gayler cited the tireless efforts of Charrise Lomax, Mike Harris, and all the division chiefs in radiology. Although the planning process was fraught with tedious details and a huge number of meetings, Dr. Gayler said he enjoyed the process, because "all healthcare planning should be patient-oriented. The goal should be to make everything better for the patient."

Case of the Quarter

If you guessed "D" as the diagnosis for the Case of the Quarter, you're correct!

During surgery, the kidney was found to have ischemic injury and a complete occlusion of the renal vein by palpation. Pathology of the resected transplant kidney showed thrombosis of the extrarenal and intrarenal veins and arteries, and infarction of the renal cortex.

Ways to Give...

For those interested in making a tax-deductible contribution in support of any program or research project in the Russell H. Morgan Department of Radiology and Radiological Science, please contact the Development Office at 410-516-8986 or jkeene1@jhmi.edu or visit www.hopkinsradiology.org.

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