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Equipment Design

High-tech creativity characterizes future for MRI, CT, ultrasound

Image fusion, higher field systems, miniaturization, and new applications suggest modalities' likely directions

By Steven K. Wagner

Sidebar: ['Smaller is better' may not apply](#)

Crystal-ball gazing, especially if it is based on the solid realities of technological developments, offers a promising glimpse into the future of MRI, CT, and ultrasound. The prospects for MRI in particular appear bright, despite some potential bumps in the road. Important new applications are under development, the computer age will more fully enhance the modality, and utilization is acceptably high for many applications.

How large MRI's piece of the cardiac and neuroimaging pie will ultimately be is unclear, however, and those percentages will substantially affect utilization numbers. When computerization will move into full swing is another unknown. What is clear is that technology holds the key to MRI's anticipated success over the next 10 years.

A good starting point for examining the modality's technological future is construction and appearance. Marconi Medical Systems, for example, emphasized magnet length when it began marketing its 1.5-tesla Infinion scanner in March. The magnet measures 4.5 feet in length, and the company claims it is the world's first ultrashort magnet. [Fig. 1]

The Infinion is intended to mitigate the longstanding claustrophobia issue, and some observers believe magnets may shrink even further during the coming decade. One bonus is that short-bore systems allow patients to be inserted feet first for most imaging studies, with the head never entering the magnet.

"We may see magnets get down to a meter in length, but I don't really see them getting much shorter than that," said Dr. William G. Bradley Jr., director of MR and radiology research at Memorial Medical Center in Long Beach, CA.

A magnet's imaging acuity is compromised when the length is shortened too much, and system manufacturers may be approaching that limit. Industry consultant Robert A. Bell of R.A. Bell & Associates doubts that further shortening is possible. He believes that 3-tesla magnets may represent the high-water mark for field strength in a generalized setting for the next decade.

Some manufacturers are already at that point. Siemens Medical Systems displayed its 3-tesla Allegra, a dedicated neurology scanner, at the 2000 RSNA meeting. The company has also shown its 3-tesla Trio whole-body

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scanner. [Fig. 2]

“Due to the cost and potential biological interactions, systems 3 tesla and higher will largely be limited to research facilities,” Bell said. “Some will be used in private practice, and they are wonderful instruments for spectroscopy and so forth. But one has to remember that power deposition goes up as the field strength increases.”

The field strength of open, or nontubular, systems may be leveling off as well, partly because of cost, Bell said. An influx of smaller systems dedicated to specific body parts, such as the breast, is encouraging to the “open-is-better” proponents, however.

MagneVu, of Carlsbad, CA, appears to be on the right track, having begun marketing a small, lightweight MRI system for orthopedic extremity imaging. The system may eventually be tweaked for breast screening, said Freeman Rose, chief executive officer. That could bring MRI to a new, highly lucrative threshold—front-line breast screening—in the next five to 10 years.

Another area that may be explored is fusion imaging, a hot topic in radiology that is likely to heat up more in the next 10 years. GE Medical Systems and Varian Medical Systems joined forces last year in a venture that combines metabolic and anatomical imaging with intensely modulated radiation therapy (IMRT) to help clinicians better detect and treat cancer. The program, called See and Treat Cancer Care, involves the use of imaging technologies, including MRI and CT, that show the location of tumors within patient anatomy. MR spectroscopy, PET, or single-photon emission computed tomography (SPECT) provide the needed metabolic information to complete the fusion equation. The process enables clinicians to collect and combine patient data using several of the imaging technologies and then develop optimal plans for therapy by fusing the images.

Multispecialty Networks

The use of MR technology by nonradiologists will continue to escalate, according to Bradley. New applications, especially those involving cardiac and neuroimaging, will help offset that trend, however.

Collaboration between radiologists and cardiologists and radiologists and neurologists will speed the development of those applications, he predicted.

While most MR suites house all major components—the imaging system, a computer, and a display—in close proximity, next-generation MRI networks will include a primary computational center that drives the image acquisition device at several locations and a visualization server using state-of-the-art software that enhances the images on many monitors simultaneously. Rather than upgrade an individual system or display device, the computational center or visualization server might be upgraded in modular fashion, thereby enhancing all systems on the network, said Ronald B. Schilling, Ph.D., president of RBS Consulting Group.

The development of MRI technology may be driven by the clinical knowledge that radiologists need for diagnosis rather than by the presumed need for faster, more powerful systems.

“The manufacturer, rather than talking about a specific modality, will talk about a disease category, the knowledge that’s required to diagnose that disease, and the technology that’s needed to acquire that knowledge,” Schilling said.

Small brain scanners will quickly indicate the state of a patient’s brain function and will identify risk areas that should be further investigated,

said Robert Gylling, vice president of MR strategic marketing for Marconi.

“Small-sized cardiac scanners, using specially developed injectable contrast agents, will produce a complete cardiac exam in five minutes. And small-sized lung scanners, using specially developed contrast gases that can be inhaled, will produce a complete functional exam of the respiratory system in five minutes,” he said.

Additionally, advances in contrast media will enable the agents to amplify MR signals and target specific areas of the body, he said.

CT Fusion

A considerably higher integration of CT and PET technology is likely in the coming years, according to Richard Hausmann, president of Siemens' worldwide CT division. Although several modalities, including MRI, are involved in fusion techniques, the widespread use of MRI combined with PET in one system does not appear likely, Bradley said.

“MR is too expensive to be combined with other modalities,” he said. “I believe it will remain a stand-alone technology.”

But there could be exceptions, he added. Focused ultrasound units may eventually be placed in some MR machines in a fusion context. The comparatively low cost of ultrasound systems would be the enabling factor.

Thus far, the combination of CT with either PET or SPECT appears to be leading the way in fusion imaging. GE, Philips Medical Systems, Siemens, and SMV showcased fusion technology at the last RSNA meeting. Such systems will constitute a force to reckon with, at least for oncology applications.

As technology swings to a different plane, scan distributions may do the same, Bell said. Virtually no cardiac MR studies are performed today, but roughly one-fourth of all body scans—which he predicts will account for about one-fourth the total number of MRI exams—will involve cardiac applications by 2010. Cardiac exams may begin trickling into the picture around 2005, he said.

“It all hinges on the ability of MR to consistently and accurately measure coronary artery occlusion,” Bell said. “We’ve handled the motion problem. Cardiac MR is very good at detecting areas of ischemia, it’s very good for wall thickness and wall motion studies, and it’s very good for congenital abnormalities and regurgitant valves.”

In addition to its emerging role in combination technology, other developments will likely affect CT during the coming years, Hausmann said. Among them may be a proliferation of flat-panel detectors and true volumetric acquisitions. The result will be faster image capture and the growth of cardiac applications, including noninvasive cardiac angiography.

“One area of significant growth potential involves what I call ‘CT that is available for everybody,’” Hausmann said. “That involves ease of use, ease of installation, and ease of service that goes far beyond what is available now in conventional scanners, and at a price comparable to x-ray or ultrasound. The barriers keeping CT out of rural areas must be minimized.”

Ultrasound Gets Small

On the ultrasound front, a number of developments that are likely to progress in the 21st century were revealed at the RSNA meeting last fall. Ease of use, improved image quality, and identification of new

applications were major themes. Some vendors sought to extend the reach of their equipment through three-dimensional technologies, and those attempts were notable for their potential effect on the future of the modality.

Ultrasound technology has progressed from analog to digital, with discrete components and proprietary hardware dominating. In the future, off-the-shelf components will enable users to take advantage of the ever-changing personal computer and telecommunications arena, said Greg Petras, general manager of Agilent Technologies' imaging division.

"The pace of feature and application changes will be much greater as we move to more standard platforms and more software-based enhancements," Petras said. "As we move to those platforms, it will be much easier to integrate third-party software programs into the machines."

Smaller, less expensive, and higher performance systems will likely emerge with the same force that laptop computers did during the 1990s, he added. Miniaturization will remain critical in both the R&D and clinical sectors.

The trend toward increased computer horsepower will affect radiology enormously, said Helen Routh, senior director of long-term strategy for ATL Ultrasound. Increased power can drive the trend toward miniaturization while lending more brawn to larger, more conventional ultrasound systems, she said.

Miniaturization will also enable clinicians to perform more complete bedside examinations, such as limited echocardiography. Also anticipated are the combination of ultrasound with bubble agents to evaluate drug delivery to specific sites, the widespread use of lightweight systems in the home, postoperative monitoring, and plug-and-play ultrasound capabilities at various locations throughout a hospital.

"As they become both cheaper and smaller, ultrasound units will find their way into many places where it's now cost- or space-prohibitive to use them," Petras said. "If you talk with most of the major players, they see real-time 3-D as something that will enhance the image display and diagnostic capability of ultrasound."

And finally, device specialization may begin to accelerate.

"Perhaps, as things get smaller, a physician in one department might pull out an obstetric ultrasound device while the guy down the hall is pulling out an abdominal device," Routh said.

Contrast agents might someday be used routinely to measure perfusion in organs, she added. Ultimately, contrast agents may become disease-specific, enabling clinicians to bundle them with drugs for delivery to predesignated sites. Technological advances could thus enable ultrasound imaging and disease therapy to become far more closely aligned.

Although they differ vastly as imaging modalities, MRI, CT, and ultrasound are all being developed to pursue a common goal as manufacturers seek future success: the ability to get their products into as many markets and into the hands of as many clinicians as possible.

Mr. Wagner is a freelance writer based in Glendora, CA.

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