



As cardiac CT interest heats up, so does EBCT, MDCT debate

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Cardiac imaging with multislice CT scanners is threatening to eclipse electron beam computed tomography, the technology that pioneered CT heart imaging. Although many believe that EBCT retains technical advantages over MDCT, practices are increasingly opting for the cheaper and more clinically versatile MDCT scanners -- raising questions about EBCT's future.

It was EBCT, the fastest CT technology available for many years, that launched heart imaging as a CT application. With temporal resolution of 50-100 msec and radiation doses as low as 0.6 mSv for calcium scoring and 1 mSv for angiography exams, EBCT offers benefits over traditional heart imaging technology such as cardiac catheterization, which delivers 2 mSv and is far more invasive.

But EBCT has its drawbacks, particularly in terms of cost, reimbursement, and clinical versatility. Both cardiologists -- who constituted EBCT's initial target market -- and radiologists have resisted the million-dollar price tags that scanners carry; radiologists have been reluctant to buy a device perceived to be designed primarily for heart imaging. As for insurance reimbursement, there is no national coverage policy for either Medicare or private insurers for any cardiac CT applications: coverage varies by region.

But EBCT's greatest challenge is coming from the new generation of 64-slice CT scanners hitting the market. With 64-slice acquisition, mechanical CT scanners seem finally to have achieved the temporal resolution needed to conduct routine cardiac scanning, while also performing all the other imaging applications required of a busy radiology practice. As a result, EBCT's primacy for cardiac applications has weakened in the minds of many clinicians, even those who acknowledge the technology's benefits.

"EBCT is great for looking at the heart because of its relatively high temporal resolution," said Dr. Geoffrey Rubin, chief of cardiovascular imaging and associate professor of radiology at Stanford University School of Medicine in Stanford, CA. "The technology remains compelling. But MDCT has such a higher market penetration due to the fact that non-EBCT scanners are more versatile than EBCT scanners."

Could the imaging market be witnessing the inevitable decline of EBCT?

History of EBCT

Introduced in the early 1970s, CT first found its niche in brain and neck imaging; at first, scans took up to five minutes to complete. When Stanford University researchers built a system that incorporated faster computer algorithms and two x-ray beams rather than one, scan time decreased to two minutes, allowing radiologists to perform full-body scanning. But CT's limitation was that it couldn't image moving organs without producing serious artifacts.

In the mid-1970s, Dr. Douglas Boyd, a Stanford researcher and partner in the radiology department at the University of California, San Francisco (UCSF), began developing a CT scanner that could capture images of the moving heart. Instead of using mechanically rotating x-ray tubes, the team used electron beams, and developed the capacity to scan contiguous sections of a patient's body without having to move them.

In 1981 Boyd and his partners founded Imatron of South San Francisco, CA, to market electron beam tomography (EBT) scanners, now called EBCT scanners; Boyd served as CEO and chief scientist until December 2004. By 1983 Imatron had begun early clinical studies using a prototype instrument; a year later, it installed its first commercial unit, C-100, at UCSF at a price of \$1.6 million.

In its first few years, Imatron installed a handful of scanners in U.S. hospitals and freestanding imaging clinics, but it was slow going. By the end of 1987, the company's global installed base consisted of just 14 units. Cardiologists balked at the scanner's high price, since they primarily used less expensive electrocardiograph and conventional x-ray cardiovascular angiography systems. Radiologists were mildly interested in the technology as a way to expand their services, but the quality of EBCT images was still disappointing.

Throughout the 1990s, Imatron placed EBCT scanners in freestanding imaging centers, and researchers performed clinical studies to establish that scanning the coronary arteries for calcium with EBCT devices, using the Agatston calcium score, offered key diagnostic data for assessing early heart disease. Many studies found the presence of coronary artery calcium (CAC) to be a statistically valid predictor, aside from traditional risk factors, of increased risk for future coronary events.

Imatron's growing profile caught the attention of multimodality vendor [GE Healthcare](#) of Chalfont St. Giles, U.K., which bought Imatron at the end of 2001. The company rolled out a completely new EBCT model, e-Speed, less than a year later. With increasing clinical validation and the backing of the world's largest medical imaging vendor, it seemed that EBCT's future success was assured.

But while Imatron was making clinical and commercial inroads, developers of mechanical CT scanners weren't sitting idle. The first multislice CT scanner, a four-slice model, was introduced in 1998, and at the 2003 RSNA show vendors began introducing the first 64-slice systems. All can be optimized for performing cardiac studies -- EBCT's bread and butter.

EBCT versus MDCT

At 50-100 msec, EBCT's temporal resolution is faster than that of the older multislice CT scanners. In comparison, a 16-row MDCT scanner has a temporal resolution of 250 msec at 0.5-second gantry rotation time, though the numbers can be improved with the use of a 0.4-second rotation speed and reconstruction algorithms some vendors offer. The new crop of 64-slice systems appears to have erased EBCT's advantage in temporal resolution, with companies claiming temporal resolution as low as 40 msec.

Another performance metric, spatial resolution, is also crucial, and EBCT falls behind MDCT in this area. GE's e-Speed has spatial resolution of 1.5 mm, but 16-row multislice scanners can produce submillimeter resolution, with 64-slice systems enjoying special resolution as low as 0.35 mm.

Yet this information doesn't paint the whole picture of the pros and cons of both EBCT and MDCT for cardiac imaging. One concern is that most MDCT scans still require the heart to be artificially slowed with beta blockers, which, in addition to the potential risk to the patient, means additional staff are needed to perform the exam. Slowing the heart is not required for an EBCT scan.

Another concern is the radiation dose patients receive during an MDCT angiography scan, which can be as high as 10 times that of an EBCT angiography scan. Retrospective gating is generally needed for CT angiography exams, improving image quality and spatial resolution, but also boosting the radiation dose exponentially.

MDCT's images don't justify the increased radiation levels, according to Dr. Matthew Budoff, associate professor of medicine at the David Geffen School of Medicine at the University of California, Los Angeles (UCLA), Harbor-UCLA Medical Center in Torrance, CA.

"EBCT angiography requires 1 mSv, and MDCT requires 10 mSv," Budoff said. "In terms of information per millisevert, MDCT is not 10 times better than data from EBCT."

MDCT vendors and clinicians have begun to address the radiation concern, at least in calcium scoring. Now, clinicians who use this test can perform prospective gating, which limits radiation exposure, leaving little difference in the dose between EBCT scans and state-of-the-art (64-slice) MDCT exams, according to Dr. Warren Janowitz, director of nuclear medicine at the Baptist Cardiac & Vascular Institute and head of cardiac CT at Baptist Hospital, both in Miami.

EBCT advocates have been wary of the correlation between clinical data collected with EBCT scanners being used with MDCT. In an [editorial](#) published on *AuntMinnie.com* in September 2004, Drs. James Ehrlich and John Rumberger argued that the science behind MDCT calcium scoring is based on literature validation from EBT technology. But there's debate between EBCT and MDCT users about whether this is a problem.

"EBT proponents talk about the fact that most of the data in the literature has been done with EBT, and argue that clinicians should not use the same database with MDCT," Janowitz said. "My personal opinion is that there are no major discrepancies (between the two). It would be preferable to generate databases specific to multislice, but in the meantime, there's no clinically significant difference."

In 2003 an international consortium of radiologists, physicists, and vendors established that calcium mass scoring would replace the Agatston score as the standard for both EBCT and MDCT to address this issue. The team considered mass to be the most flexible measurement in terms of portability from scanner to scanner and vendor to vendor. But some have criticized this effort as well, citing the same paucity of data from human studies.

The future of EBCT

When GE bought Imatron, EBCT users began to hope that, with the addition of the healthcare giant's R&D and financial support, the technology would further realize its potential. In the first few years after the acquisition, GE Imatron added two scanners to its lineup, C300 and its next-generation e-Speed system. The company also focused on expanding the

technology's applications by adding perfusion and wall-motion analysis, low-dose lung scanning, and virtual colonoscopy to its existing calcium scoring capability.

But the reality has not measured up to expectations. According to Boyd, now director of Heart Scan Imaging Center in Walnut Creek, CA, Imatron had 300 employees on its payroll when GE acquired it; it had 25 when he left in December.

Imatron's status has affected some EBCT center owners. Carl Guerra, owner of Cardio Care in Henderson, NV, experienced difficulty in getting retrofits for his center's C150, and after three weeks of downtime, contacted a third party to fix the scanner. Steve Brunst, CEO and managing director of InnerVision Wellness Imaging in Carlsbad, CA, has found GE Imatron's maintenance of his company's EBCT scanner more than adequate, but has been increasingly unclear on GE's intentions regarding the technology's future. He acquired his facility's scanner in 2001, just as GE was buying Imatron.

"From an owner's perspective and a customer's perspective, there's been a slow degrading in their attention and their interest," Brunst said. "This has been compounded by a very poor level of communication between the sales division of GE and EBCT owners. We're basically in the dark about what's coming down the road. I look to GE as my partner, but they're not coming to us with any kind of game plan."

Other EBCT users, like Budoff, who conducts EBCT scans at Harbor-UCLA Medical Center's St. John's Cardiovascular Building in Torrance, CA, and Ron Pruitt, vice president of operations at Heart Savers in Cupertino, CA, have not experienced any change in the quality of GE Imatron's technical support. Neither has Bruce Friedman, president of Heart Check America in Los Angeles. But the specter of GE's possible dismantling of its EBCT program continues to menace.

"We haven't had any problems or difference in service (since GE bought Imatron), although occasionally it takes longer for us to receive a part," Friedman said. "But the communication has been decreasing, and there are definitely less people on the EBT side (of GE). The folks at GE continue to tell us that they view EBT as a valuable technology and platform moving forward, but it doesn't appear so when you watch what they're doing as opposed to what they're saying."

Boyd attributes what appears to some to be GE's pullback to market forces sparked by the terrorist attacks of September 11, which caused a deep recession in the screening center market. Imatron's main business was selling to those centers, and many of them went out of business in the first few years after the attacks. With the simultaneous development of increasingly sophisticated MDCT scanners, interest in EBCT technology faltered.

"Imatron was a new acquisition for GE, and (post-September 11) the company had negative growth, so it didn't make a good impression," Boyd said.

In an e-mailed statement, GE Healthcare spokesperson Kristin Binns said GE remains committed to EBCT.

"GE Healthcare continues to sell, manufacture, and develop the e-Speed system, our current EBCT product. In addition, we continue to service and maintain more than 100 C150, C300, and e-Speed EBCT systems around the world," Binns said. "Beyond the e-Speed system, GE Healthcare and GE Global Research engineers and scientists are also advancing electron beam technology as a foundation for long-term, ultra-advanced CT systems. Like many companies developing groundbreaking technologies, GE Healthcare continues to assess market trends and customer needs in order to guide business strategy and adjust our operations accordingly."

Whether EBCT is indeed the better technology for cardiac imaging may prove moot, however, in an imaging market geared primarily to radiologists who want flexibility in their equipment. But Boyd cautions that it's probably too soon to tell.

"Multislice may play out in the next few years," he said. "And companies may start to develop no-motion CT scanners like EBCT. I don't think one can extrapolate into the future based on short-term trends."

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