Extreme multi-slice CT: opportunities & challenges

Profound technological changes in computed tomography (CT) technology have occurred over its three-decade existence. However, these advances have led to mostly incremental changes in how this technology is applied towards patient care. With the advent of extreme multi-slice CT (64-slice CT scanners), it is apparent that revolutionary changes in the clinical applications of this technology can occur. The increased utility of CT for many clinical applications, including cardiac imaging, challenges the very nature of how CT is used clinically. With these changes, there are opportunities and challenges that the radiological community must face. In addition, the increased use of CT in diagnostic medicine presents concerns in regards to the radiation exposure to patients.

John M. Boone, Ph.D.

Potential and expectations

The opportunities that extreme multi-slice CT offers are a result of the improvements in temporal and spatial resolution. The improved temporal resolution, combined with techniques that allow gating of the cardiac cycle, usher in an era where computed tomography will undoubtedly replace diagnostic cardiac catheterisation procedures. The rapid scanning capabilities of these systems also create new potential for high temporal resolution outside of the heart, including peripheral vascular imaging, joint motion evaluation, and functional organ imaging (with the use of contrast agents).

Extreme multi-slice CT scanners, unlike the previous generation of 16-slice scanners, now offer rapid coverage (4 - 8 cm per gantry rotation) as well as isotropic resolution. These scanners allow thin-slice CT reconstructions, where the z-axis resolution is comparable to both the x-axis and y-axis resolution. Thus, the excellent detail traditionally seen in the CT axial plane is now also present in coronal, sagittal and off-axis planes. Isotropic resolution represents an enormous opportunity for radiologists to update and optimise viewing strategies, which can lead to better diagnostic interpretation. Cross-sectional coronal imaging of the thorax is a potential example of this.

Challenges

Along with these opportunities, numerous challenges emerge as a result of the high temporal and spatial resolution of extreme multi-slice CT scanners. The high temporal resolution combined with the multi-planar imaging capabilities of these systems present great opportunities towards developing CT procedures with greater functional information, however existing paradigms for CT scanning and interpretation must be profoundly altered to make full use of this new technology. The challenges that face radiologists and others in the radiological community, therefore, are to develop new CT acquisition protocols and interpretation strategies that fundamentally improve the diagnostic utility of computed tomography.

Extreme multi-slice CT scanners will require potentially expensive modifications to existing infrastructure. The lead shielding in the CT room needs to be re-evaluated, due to the higher throughput of these systems and the use of higher radiation levels per patient for procedures such as vascular imaging. In order to utilise the potential of isotropic resolution, thin-slice CT reconstruction should be the norm. CT slices should be reconstructed for each detector row, implying that each slice will be between 0.5 mm and 0.6 mm in thickness. Thus, a 30-cm scan volume will produce 600 CT images. These datasets will require, in many cases, improvements in the bandwidth between the CT scanner and the picture archive and communication system (PACS), and between the PACS system and the diagnostic workstations. In many cases, both the hardware (memory) and the software capabilities of primary interpretation workstations will need to be updated to accommodate these larger datasets for interpretation. Another important challenge that radiologists face with the acquisition of an extreme multi-slice CT scanner is to redesign the acquisition protocols for breathing, contrast injection, and CT scanning.

The increase in CT utilisation in past years is a growing concern in the radiological community. It is estimated that 62 million CT scans were performed in 2005 in the United States alone. One CT scan for every five man, woman and child. The collective dose from this enormous use of computed tomography is significant, and currently CT is the largest anthropogenic contributor to radiation dose to the American population. As CT utilisation increases, and CT studies become more complex (more dose per study), there will be an increase in radiation-produced cancers years from now. While clearly the short-term benefits of receiving a CT scan may significantly outweigh the very small and long-term risks of developing cancer from the examinations, it is recognised that CT use should be medically justified for each and every patient. Radiologists therefore are in the unenviable position of trying to reduce CT utilisation in the face of growing clinical applications of this imaging modality.