

In recent years, the norm for new angiography gantries has become the ability to rotate the x-ray source and detector assembly around the patient so as to obtain enough projection views and enable a complete computer back-projection calculation to be made followed by a display of 3D vascular trees. This cone-beam computed tomography where multiple cross-sectional planes of the patient are taken simultaneously has enabled quicker and better diagnoses as well as more accurate selection of views during subsequent treatment. Most recently, it has become apparent that extreme accuracy may only be necessary at the site of an intervention and hence that truncated or region-of-interest cone-beam CT, rather than full field CT, is required. The use of high spatial resolution detectors over a small region of interest near the site of an intervention, usually near the catheter tip, has enabled the possible use of new endovascular devices, such as an asymmetric stent, for treatment of neurovascular aneurysms. The combination of high spatial resolution, 3D determination of vessel lumen, and new patient specific endovascular interventional devices appears to be leading to a new paradigm in the treatment of vascular disease that may influence the way in which the medical physicist relates to such therapies. Just as the therapeutic medical physicist may be involved closely with radiation therapy treatment plans for individual patients, the imaging physicist may become increasingly involved with the individual intervention for vascular patients. Once a patient's vessel lumen has been determined from high resolution ROI cone-beam CT, the detailed blood flow patterns could be calculated using computer fluid dynamic (CFD) software. A patient-specific endovascular therapeutic device could then be designed, and its potential impact in flow modification, e.g., the closing off of an aneurysm using an asymmetric stent, could be optimized in simulations. Next, the device would be either fabricated or selected from available devices. The patient would then be treated under high-resolution image guidance and evaluation of modified flow made using image analysis and further CFD calculations. The imaging physicist would play a unique role in the design, evaluation, and guidance of future minimally-invasive vascular interventions.

Educational Objectives:

1. To review cone-beam CT based on rotational angiography.
2. To explain the problems associated with truncated CT and how ROI CT may solve these and provide adequate 3D imagery near the site of an intervention.
3. To discuss microangiography detectors and their possible application.
4. To introduce new endovascular interventional devices such as asymmetric stents.
5. To introduce a new treatment paradigm and potential new role for imaging medical physicists involving the combination of image analysis, flow calculations, endovascular device design, and image-guided interventions.

(Partial support: NIH Grants R01EB002873 and R01NS43924, Toshiba Medical Systems Corp., UB Foundation, UB-STOR, Guidant Corp.)