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C-Arm Cone-Beam CT: Principles, Practicalities, and Applications

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This session surveys the topic of C-arm cone-beam CT (CBCT), including principles of 3D reconstruction, image quality, radiation dose, quality assurance, and clinical applications. The availability of such systems has grown over the past several years, particularly in light of performance enhancements gained through the incorporation of a flat-panel detector (FPD) in the imaging chain in place of conventional x-ray image intensifiers. Such FPD-based systems demonstrate increased field of view, higher 3D spatial resolution, improved noise characteristics, and the capability to visualize soft-tissue structures. Applications include neurovascular and cardiovascular image-guided interventions as well as a growing spectrum of nonvascular and tumor surgeries. The basic principles of cone-beam CT image reconstruction are reviewed (focusing on prevalent implementations of the Feldkamp algorithm) in comparison to conventional fan-beam filtered backprojection. The influence of image artifacts most relevant to C-arm cone-beam CT are reviewed – in particular, x-ray scatter, object truncation, and the "cone-beam" artifact. The factors governing 3D image quality are explained, with emphasis on the ability to image soft-tissue structures, and issues of radiation dose characterization and quality assurance are discussed. An ever-increasing spectrum of C-arm or C-arm-like cone-beam CT systems is discussed in relation to various applications. Emphasis throughout is in regard to factors most relevant to the practicing medical physicists.

Learning objectives: Attendees will gain practical understanding of:

1.) Basic principles of 3D cone-beam CT reconstruction
2.) Image quality and artifacts most relevant to cone-beam CT
3.) Essential factors pertinent to C-arm cone-beam CT quality assurance
4.) Spectrum of systems and applications of C-arm cone-beam CT