AbstractID: 7009 Title: Tomosynthesis and Cone-Beam CT on a Mobile C-Arm for Image-Guided Interventions

Purpose: A prototype mobile C-arm capable of real-time fluoroscopy, tomosynthesis, and cone-beam CT (CBCT) has been developed for intraoperative guidance of minimally invasive procedures. This work investigates the imaging performance, radiation dose, and image acquisition / reconstruction time associated with a range of 3D imaging techniques. In addition, protocols for intraoperative use are developed for implementation in clinical research trials.

Method and Materials: Imaging performance was assessed in terms of spatial resolution as well as soft-tissue and bony detail visualization in phantoms and cadavers. Image reconstruction via 3D filtered backprojection was performed across a range of tomosynthesis angle (10^{o}–178^{o}) and number of projections (5–200). The corresponding radiation dose was evaluated analytically and experimentally (using a Farmer chamber in cylindrical head and body phantoms) to quantify peripheral, central, and organ dose (e.g., dose to the eyes). Acquisition / reconstruction times were benchmarked in relation to operational time constraints.

Results: CBCT images exhibited sub-mm spatial resolution and soft-tissue visibility (~20 HU) sufficient for interventional guidance at a central dose of 10 mGy. Tomosynthesis offered a useful, high-speed adjuvant to CBCT, providing visualization of high-contrast features at a fairly limited arc – e.g., visualization of the clivus (skull base) achieved at angles down to ~30^{o} (central dose ~1.6 mGy). Reconstruction times were ~62 sec (full CBCT volume, 0.8 mm voxels) and ~20 sec (tomosynthesis “slab,” 0.4 mm voxels), respectively.

Conclusion: C-arm tomosynthesis and CBCT provide a valuable addition to the image guidance arsenal. The former offers fast, low-dose 3D images sufficient for guidance with respect to high-contrast bony features. The latter offers sub-mm spatial resolution and soft-tissue visibility at the cost of time and dose. Deployment of the C-arm prototype in clinical research trials promises increased surgical precision, with protocols for intraoperative imaging consistent with operational time and dose constraints.