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The Value of Volume of Interest (VOI) C-arm CT Imaging in the Endovascular Treatment of Intracranial Aneurysms - A Feasibility Study

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Abstract:
Purpose: During endovascular treatment of intracranial aneurysms, it is very crucial to understand the relationship of the deployed devices such as stents, flow diverters, and coils to the parent artery and adjacent normal branches. Although existing C-arm CT imaging techniques provide such information, the repeated intra-procedural use of C-arm CT is limited due to increased radiation dose delivered to the patient. We propose to evaluate the feasibility of a new VOI imaging technique that creates high quality 3D images of the selected region of interest for intermediate updates and image guidance during the procedure without significant increase in radiation.
Materials & Methods: VOI images were obtained in 10 patients undergoing endovascular treatment of intracranial aneurysms. The VOI images were acquired by iso-centering the C-arm around the implanted device using a standard 20s DR DynaCT (Axiom Artis Zee, Siemens AG, Forchheim, Germany) acquisition with the X-ray source collimated on the VOI. The size of the VOI is approximately 12% of the full volume. The VOI images are reconstructed using the reconstruction software provided by the angiographic systems as well as using an offline prototype reconstruction algorithm.
Results: The images from full volume and VOI acquisitions are reconstructed with similar reconstruction parameters with a resolution of 0.2 mm/pixel and compared to each other. Qualitative analysis shows that the VOI images are comparable to secondary reconstructions from a full volume acquisition (See Figure 1). The cumulative dose is significantly reduced with VOI scan resulting in a reduction of 91.8% in dose area product when compared to the full volume scan.
Conclusions: VOI imaging allows additional and repeated C-arm CT acquisitions on the same patient during the endovascular treatment without significant increase in radiation exposure. VOI imaging after a stent/flow diverter deployment or during the coiling of the aneurysm provides immediate feedback on the device placement and the vessel apposition of the implanted devices. Moreover, the implanted devices from VOI images can be segmented

and overlaid on fluoroscopic images for image guidance during the procedure. The acquisition of VOI images can be difficult due to the dependency on iso-centering the C-arm around the aneurysm or the deployed devices. Further improvements are needed to adaptively collimate the C-arm around the region of interest. Nevertheless, VOI imaging technique can be a valuable tool to provide image guidance during the treatment, to assess treatment efficacy and to potentially improve the clinical outcomes, all without increasing the radiation dose.

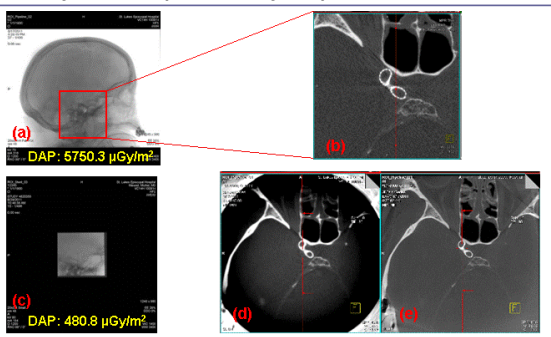

Fig 1(a): (a) Full volume scan, (b) secondary reconstruction from a full volume scan, (c) VOI scan, (d) standard reconstruction of VOI scan, (e) offline prototype reconstruction of VOI scan

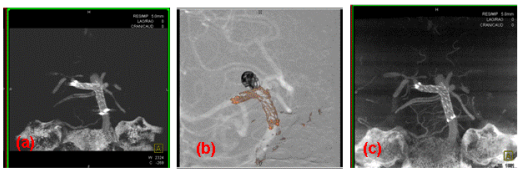

Fig 1(b): (a) Standard reconstruction of VOI scan after stent deployment and before coiling, (b) Stent segmented from (a) and overlaid on to fluoro for image guidance during coiling, (c) Offline prototype reconstruction of the same VOI scan with truncation artifact correction.

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