Metal Artifact Reduction of Coil Mass Artifacts in High resolution Flat-Detector Cone-Beam Computed Tomography of Cerebral Stent-Assisted Coiling

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Disclosures

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DR, PvdH, BC:	Employed by Philips Healthcare
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AKW:	Ownership stock in Surpass Medical; Has been a consultant per hour for Codman Neurovascular, Stryker Neurovascular, Boston Medical Associates, and Surpass Medical Ltd.; receives research support from Philips Healthcare

Disclaimers

- Mention of device names do not constitute as endorsement

Flat Panel (Angiographic) C-arm Systems

- ✓ C-arm systems enable:
  - ✓ 2D x-ray imaging for interventional guidance
  - ✓ Cone beam computed tomography (CBCT) acquisition, which provides *in situ* 3D angiographic and soft tissue imaging.

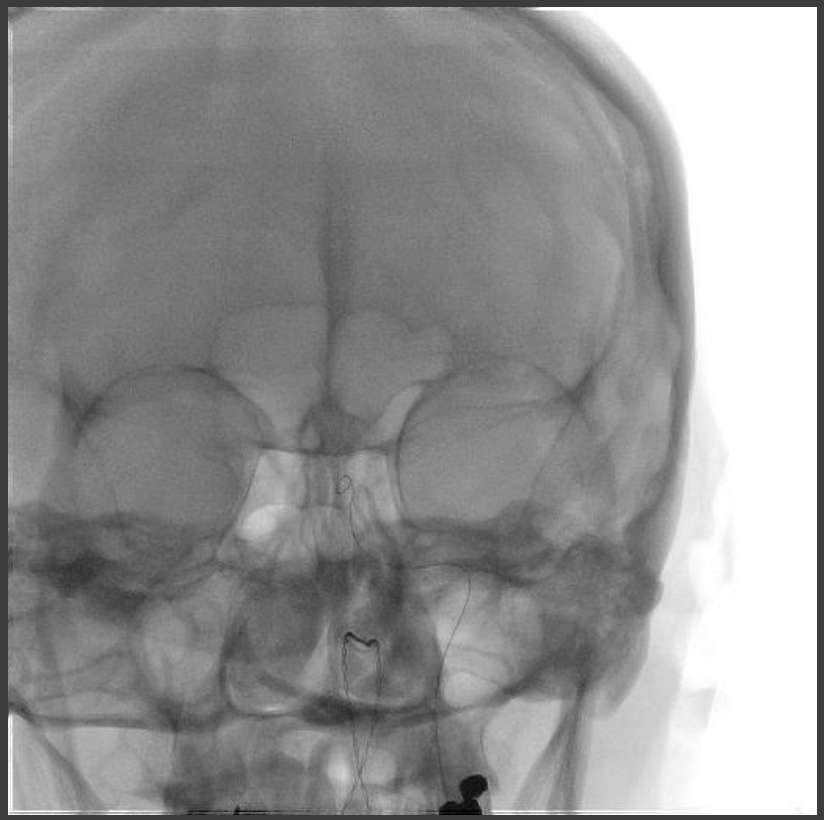

Fig. 1

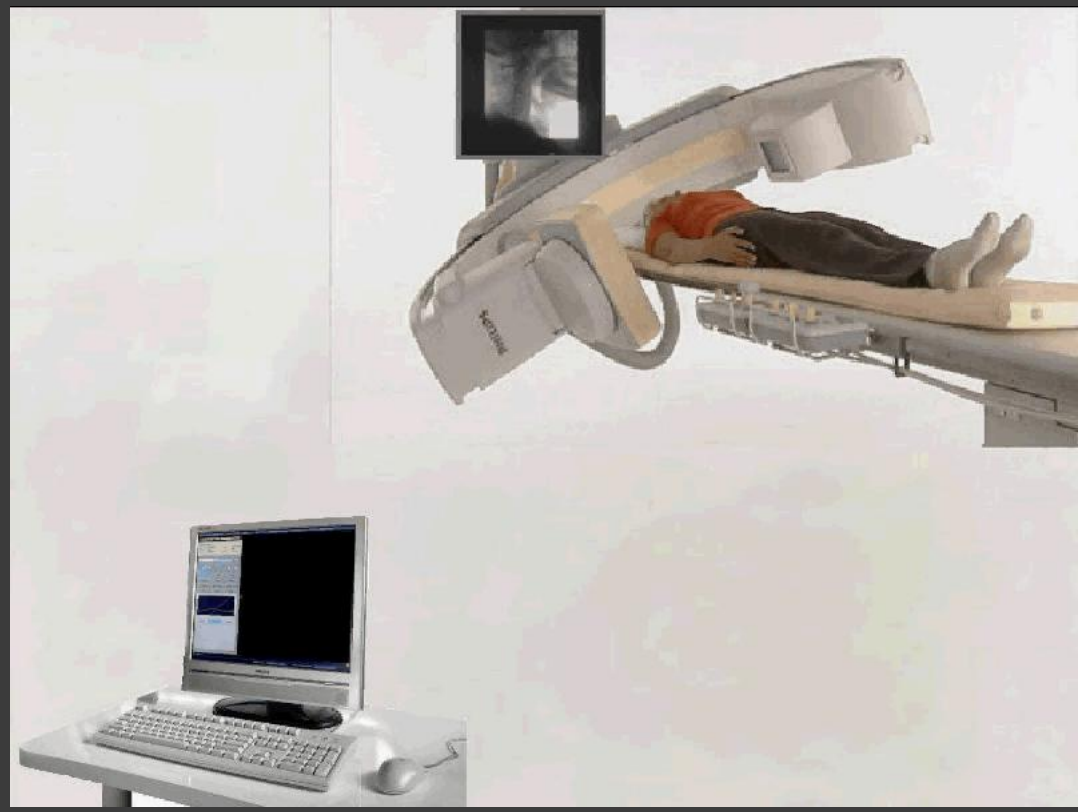

Fig. 2

Flat Panel (Angiographic) C-arm Systems

3D Rotational Angiography

(aneurysm in rabbit by elastinolysis of the R common carotid artery)

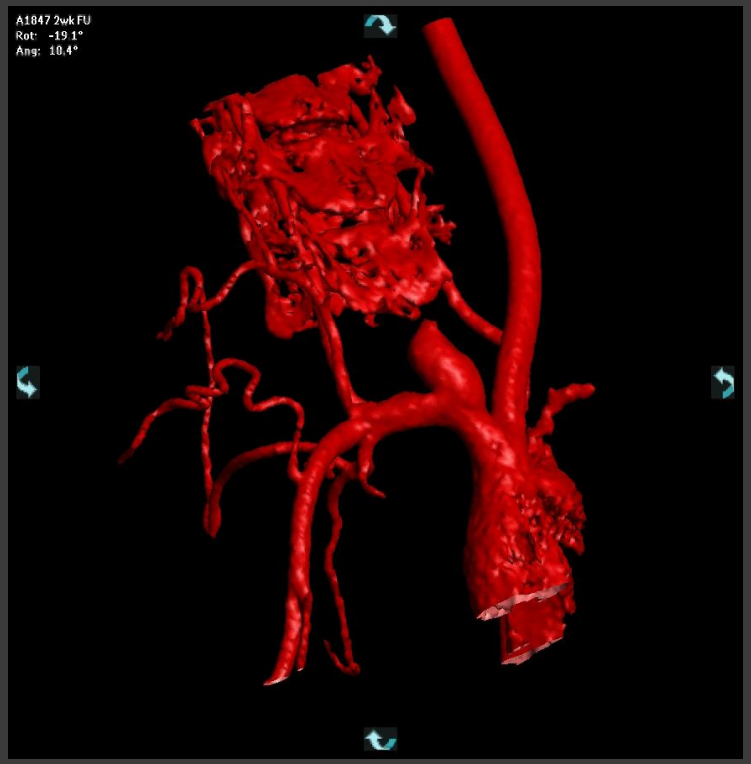

Fig. 1

Cone-Beam CT

(contrast-enhanced CBCT of brain)

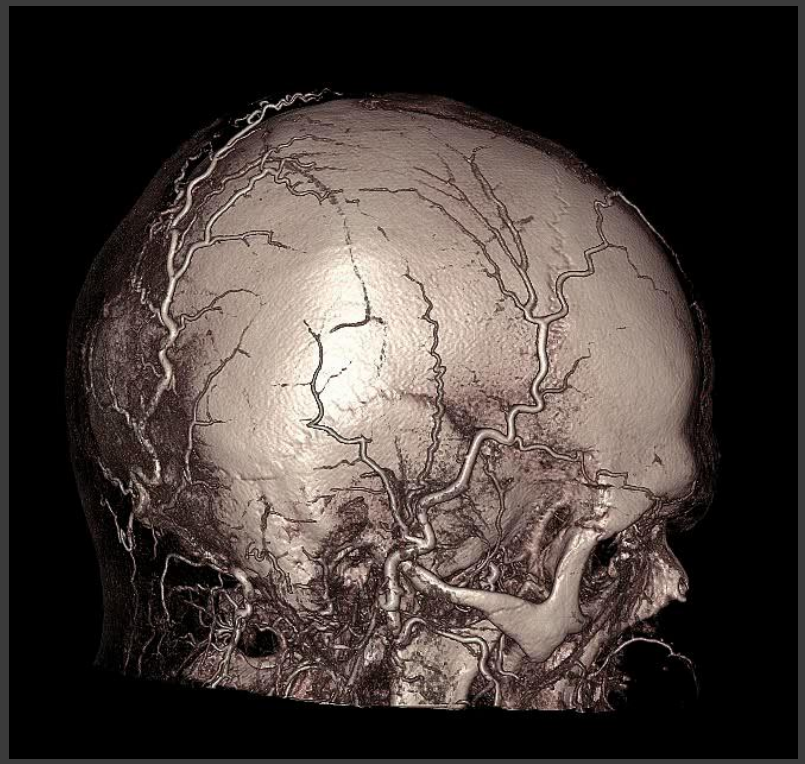

Fig. 2

Cone-Beam Computed Tomography (CBCT)

- ✓ Developments in flat-detector technology and reconstruction algorithms has improved image quality, opening the enabling:
  - ✓ CT-like image quality provides assessment of cerebral blood volume in the angio-suite(Fig. 5)
  - ✓ Reduced detector format and non-binned a reconstruction algorithm provides visualization of vasculature and intracranial stents (Fig. 6)

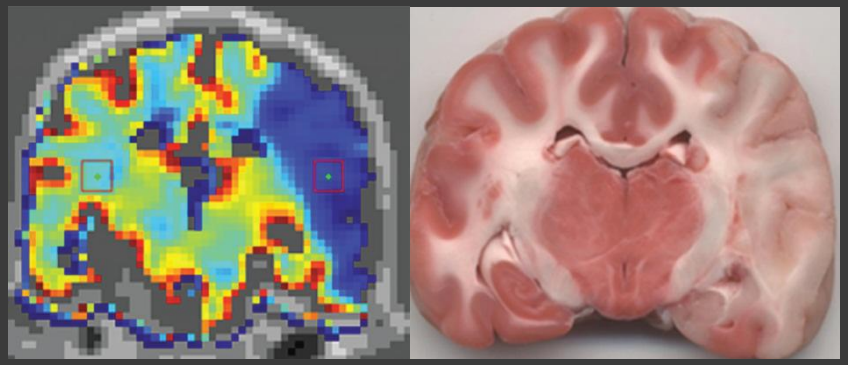

Fig. 5 - van der Bom *et. al.* JNIS, 2011

Fig. 6 - Patel *et. al.* AJNR, 2011

Contrast-Enhanced CBCT

- ✓ Because of its 3D spatial information and detailed visualization of neurovascular stents and host arteries, contrast-enhanced CBCT would be very valuable in follow-up imaging of patient that underwent intracranial stenting.
- ✓ Unfortunately, visibility of arteries and stents is severely impeded by artifacts generated by adjacent coil mass due to photon starvation, in case of stent-assisted aneurysm embolization.

Purpose

- ✓ Here, we report on the use of a metal artifact reduction (MAR) algorithm for contrast-enhanced CBCT (VasoCT[1]) with the objective to improve visualization in cases of stent-assisted aneurysm embolization

[1]Patel *et. al.* AJNR, 2011

Materials & Methods

- ✓ VasoCT data was acquired in 25 patients that underwent stent-assisted coiling (Allura Xper FD20, Philips Healthcare).
- ✓ Non-binned reconstructions were generated with and without MAR (FOV: 34^3cm, 256^3 matrix)
- ✓ For all 25 cases, both reconstructions were reviewed by three neuroradiologists on a dedicated workstation:
  - ✓ Visibility of the stent, host vessel, and the relationship between the stent, vessel, and coil mass were scored using a 3-point scale (1: visibility is insufficient for evaluation, 2: visibility is good, 3: visibility is excellent).
  - ✓ Observers were asked whether the metal artifact was obscuring the vessel beyond the coil mass.
  - ✓ Observers were asked which of the two reconstructions offered the overall better visibility.
- ✓ The results were analyzed using raw agreement statistics
- ✓ Robustness of the rating system was tested with Fleiss' kappa-method.

Results

- ✓ Figure 7: representative VasoCT data of post stent-assisted embolization of a left posterior communicating artery aneurysm without (left) and with metal artifact reduction (right).

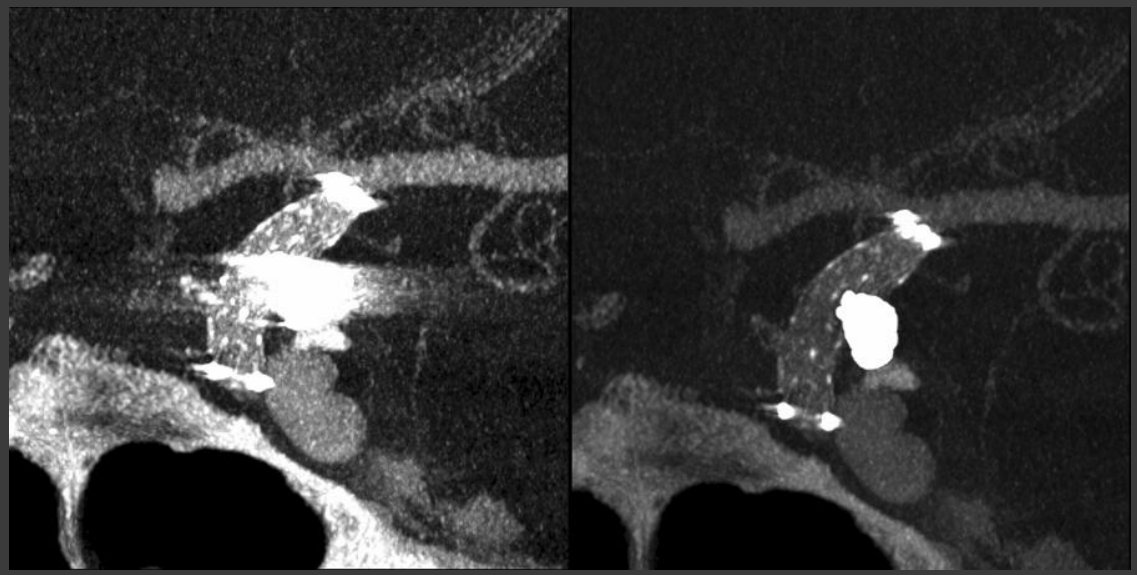

Fig. 7

Results

Without MAR:

- ✓ In more than half of all cases, all observers agreed that visibility of stent, vessel, and the relationship was insufficient for evaluation (κ = 0.66 – 0.72).
- ✓ In 56% of all cases, all observers agreed that the artifact was obscuring adjacent anatomy without MAR (κ = 0.5).

With MAR:

- ✓ All observers agreed that the visibility of the stent, vessel, and the relationship between stent, vessel, and coil was improved by at least 1 point on the scoring system by MAR in approximately 50% of the cases (κ = 0.6).
- ✓ The artifact was not obscuring the vessel in 64% of the cases (κ = 0.6).
- ✓ The visibility was sufficient for evaluation (score $\geq$ 2) in 68% of the cases.

- ✓ Overall, the observers concluded that the visibility of the reconstruction with MAR was better than without in 92% (κ = 0.9)

Conclusions

- ✓ Although MAR is not capable of fully removing metal artifacts, our study shows that the image quality of VasoCT improves visualization of the parent vessel, stent and coil mass as well as adjacent anatomy previously obscured by the streak artifacts.
- ✓ The impact of the artifacts on the visibility varied between cases, and yet the overall visibility of the contrast-enhanced CBCT improved in the majority of the cases.
- ✓ A more extensive evaluation of MAR of VasoCT data on a larger patient population is in progress.