Utility of Intra-Arterial Cone Beam CT Angiography in the Detection and Treatment of Intracranial Micro-Arteriovenous Malformations

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Introduction

Micro-arteriovenous malformations (mAVMs) represent about 8-10% of surgically treated brain AVMs, and may be an unrecognized etiology of intracerebral hemorrhages of unknown origin.
The aim of our study was to:

- Assess the diagnostic value of intra-arterial cone-beam CT angiography (IA-CBCTA) relative to digital subtraction angiography (DSA) in the diagnosis, anatomic identification and localization of intracranial mAVMs
- Assess the treatment planning value of IA-CBCTA.

Methods

- Two blinded interventional neuroradiology observers scored DSA and IA-CBCTA **images** of mAVMs based on a qualitative scale from **0-2** (2: excellent/good visibility; 1: Poor/relevant visibility with restrictions; 0: non-diagnostic) for the mAVM components.
- Two vascular neurosurgeons reported their presumed **treatment** strategy at the end of DSA and IA-CBCTA of the last follow up imaging study before the definitive management, and scored the adjunctive value of IA-CBCTA according to a scale of **0-2** (2: altered treatment plan, 1: more confident treatment plan, or 0: no value)

- Inter-observer agreements were assessed using Kendall's t coefficient. Wilcoxon's test was used to compare scores of image quality parameters as appropriate. Differences between CBCTA and DSA scores were defined as the CBCTA efficacy value.
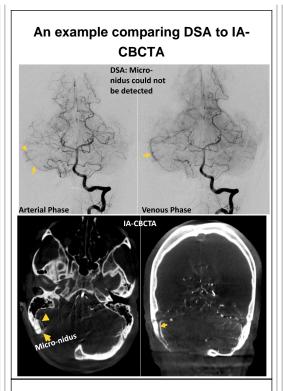
Results

- Ten patients (6F:4M; mean age 43 ± 19; range 10-69 years). Eight of 10 patients presented with intracerebral hemorrhage (80%), (Mean volume 20.3 mL, range 0.5–55.5 mL). Nine patients (90%) presented with neurological deficits.
- Both observers graded **IA-CBCTA** for **the micro-nidus component** of all the mAVMs as grade 2 (excellent visualization). There were differences in DSA nidus grading with fair agreement (t coefficient = 0.47).
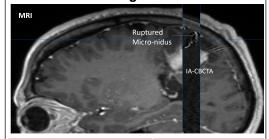- Both Observers, overall, assigned higher **total IA-CBCTA diagnostic score** with Good agreement (t coefficient = 0.57)
- High relative IA-CBCTA efficacy value when evaluating **arterial feeders** (observer 1: p = 0.02, observer 2: p=0.03)
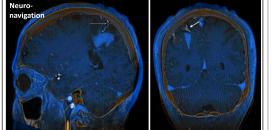- No significant differences were seen between DSA and IA-CBCTA scores (low relative IA-CBCTA efficacy value) when evaluating **venous drainage** (observer 1: p = 0.157, observer 2: p=0.564)

- Both neurosurgeons agreed that integrating the IA-CBCTA data in the neuro-navigation system would allow more confident localization and microsurgical resection/stereotactic radiotherapy. The agreement between the two neurosurgeons for the **treatment planning efficacy** of IA-CBCTA was good (t = 0.73).

An example comparing DSA to IA-CBCTA

DSA: Micro-nidus could not be detected

Arterial Phase | Venous Phase

IA-CBCTA

Micro-nidus

Integrating IA-CBCTA in Neuro-navigation

MRI — Ruptured Micro-nidus — IA-CBCTA

Neuro-navigation

Conclusions

Intra-arterial CBCTA improves the diagnostic identification and anatomic delineation of mAVMs, with the potential to improve microsurgical or stereotactic radiation treatment planning.

Learning Objectives

- Micro-AVMs are often occult neurovascular lesions that are diagnosed after the presentation of an intracranial hemorrhage (80%), and/or neurological deficits (90%).
- We directly studied IA-CBCTA and DSA modalities in parallel to assess the relative efficacy of IA-CBCTA in the anatomic identification and localization of mAVMs. IA-CBCTA improves the anatomic delineation of mAVMs, particularly for the arterial feeder and nidus site enabling a more confident diagnosis and treatment plan.