

CONTRAST-ENHANCED MAGNETIC RESONANCE ANGIOGRAPHY (CE-MRA) FOR DETECTION OF REPERFUSED PULMONARY ARTERIOVENOUS MALFORMATIONS (PAVM) AFTER COIL EMBOLIZATION IN PATIENTS WITH HEREDITARY HEMORRHAGIC TELANGIECTASIA (HHT)

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Purpose: The aim of our study was to evaluate CE-MRA as an imaging modality for detection of reperfused PAVMs after coil embolization in patients with HHT.

Patients and Methods: Between January 2000 and August 2008, 282 patients with diagnosed HHT or first degree relatives underwent screening CE-MRA at 1.5T with gadobenate dimeglumine (MultiHance; 0.1 mmol/kg bodyweight) for cerebral, pulmonary and visceral manifestations of HHT. A total of 164 PAVMs in 56 patients were treated during this period. In each case the feeding vessel was successfully embolized using platinum coils. Follow-up studies of treated patients were performed at 3 months, 12 months and thereafter at one year intervals following interventional therapy. If reperfused PAVM (rPAVM) were detected on CE-MRA, catheter angiography (CA) was performed for confirmation and re-embolization.

Results: rPAVMs were detected in 10 patients on CE-MRA or CA. Reperfusion was detected on CE-MRA for 7 out of 164 embolized PAVMs detected in 6 of 56 patients treated at our hospital, and in 6 PAVMs in 3 patients who were primarily treated at other centers. In the remaining patient who was embolized at another center using stainless steel coils, CE-MRA as well as CT could not accurately depict the area of embolization; in this patient indirect signs of reperfusion (decreased oxygen saturation and microbubble ultrasound studies) resulted in CA and hence depiction of rPAVMs. All patients with signs of PAVM reperfusion on CE-MRA underwent CA. Except in the one case of stainless steel coils, in which CT and MRI failed to depict the area of embolization, CA revealed no additional rPAVMs. However, in three patients initial global pulmonary angiography of the right or left pulmonary artery did not reveal rPAVMs. Only after selective or superselective catheterization of the segmental artery or the feeding vessel reperfused PAVMs were demonstrated. All rPAVMs were successfully re-embolized. On the basis of our results PAVM embolization failure occurred for one of three reasons: opening of collateral feeding vessels (2 PAVMs in 2 patients), insufficiently tight packing of the embolization coils (9 PAVMs in 6 patients), and corrosion of tungsten coils (2 PAVMs in 1 patient, 2 years after initial treatment). Platinum or tungsten coils did not cause any relevant artifacts on CE-MRA; in these patients CE-MRA proved helpful to guide CA, particularly when corresponding DSA projections were compromised by overprojecting embolization material. However, in the patient treated with stainless steel coils artifacts did not allow evaluation of the embolized area neither on CE-MRA or CT.

Conclusion: Reperfusion of initially successfully treated PAVMs may occur long after embolization. For this reason regular follow-up studies are mandatory. In this setting, CE-MRA proved a useful imaging modality and is feasible in patients in which platinum or tungsten coils were used for embolization. The results of our study show that:

- In addition to potentially improving the detection of PAVMs in patients with HHT undergoing screening, CE-MRA is also a useful tool for detection of PAVM reperfusion following embolization with tungsten or platinum coils.
- CE-MRA allows detection of reperfused vessels as well as newly developed collateral supply to treated PAVMs.
- CE-MRA is more sensitive than global CA and as sensitive and specific as selective CA in detection of rPAVMs.
- Patients treated with stainless steel coils cannot be evaluated adequately, either with CE-MRA or CTA.

CE-MRA demonstrated high accuracy for detection of rPAVMs as compared to CA as gold standard. CE-MRA showed no false positive rPAVMs when compared to superselective CA. Furthermore, CA in the 9 patients that could be evaluated revealed no additional rPAVMs. Because regular follow-up studies are necessary, CE-MRA may be preferable to CTA due to the absence of radiation exposure. Furthermore beam hardening artifacts, which may hamper imaging quality at the region of the implanted metal coils, do not occur on CE-MRA and the artifacts caused by platinum coils are minimal.



Fig. 1 a) 46-year old male patient 2 years after embolization of a simple PAVM in the right lower lobe. Whereas CE-MRA (a) clearly depicts reperfusion of the embolized feeding vessel, unselective DSA of the right lower lobe (b, c) is not able to visualize the reperfused simple PAVM. Only superselective DSA proves CE-MRA to be correct (d) and successful re-embolization was performed (e).