Intravascular Imaging of the Carotid Artery using a combined Stent and Imaging Catheter in a Porcine Model

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Objective: Transfemoral catheterization of the carotid arteries and stent placement under guidance of MRI has been reported in animal models.[1] High resolution intravascular MRI in vivo has been demonstrated in the abdominal aorta of pigs. Combining imaging and treatment properties in one endovascular device provides additional functional and anatomical information from the target region, potentially reduces procedure times and may increase the procedure safety. Therefore we built a prototype stent delivery and imaging device to combine these properties. The aim of this study is to (1) determine whether MR guided transfemoral catheterization of the carotid arteries is feasible with a combined stent and imaging catheter; (2) assess multiple MR pulse sequences for high resolution intravascular imaging of the carotid artery vessel wall; and to (3) simultaneously image the stent post-deployment in a porcine model.

Material and Methods: All animal examinations were approved by the Institutional Animal Care and Use Committee. Standard 7 French (Fr) stent catheters (Angiomed, Bard, Karlsruhe, FRG) were modified by adding a single-channel opposed solenoid receive coil resulting in a 12 - 14 Fr outer diameter. Under general anesthesia, the stent catheters were introduced into the carotid arteries of 6 domestic farm pigs using a j-shaped 0.035 inch guide wire (Somatex, Teltow, FRG). For catheter guidance, a real-time catheter tracking sequence (TrueFISP Interactive Real-Time Tip Tracking) was adapted to the short bore 1.5 T interventional MR scanner (Magnetom Espree, Siemens, Erlangen, FRG). The catheter position was verified by periodic intraarterial injections of 2% diluted contrast agent (Magnevist, Berlex, Wayne, NJ) during near-real-time imaging. Rapid high resolution images of the artery and surrounding tissue were acquired before stent placement. The protocols, shown previously to be useful in intravascular imaging[2] included small field-of-view TrueFISP, HASTE, spin echo-EPI, segmented EPI, SE and TSE sequences with an in-plane resolution of 300 µm and 3 mm slice thickness. After stent deployment, we introduced a 5 Fr MR imaging catheter (MR Eye, I3, Cleveland, OH) into the stent lumen and acquired images via the same set of pulse sequences. All vessels were then harvested for pathological evaluation.

Results: (1) Successful access to the carotid arteries solely under MR image guidance was obtained in 6 of 6 animals. The guide wire was useful to maneuver the semi-rigid catheter tip around the origin of the brachiocephalic trunk and its trifurcation. The catheter tip position was documented by intraarterial contrast application. (2) High resolution vessel wall images were acquired with the device and all applied sequences allowed differentiation of the vessel wall from other tissue in each animal. On T2 TSE, T2 SE and T1 SE sequences multiple layers of the vessel wall (arrows) could be distinguished (Fig. 1a). With an acquisition time of 11s/slice TrueFISP sequences showed two different layers of the vessel wall and allowed clear vessel tissue differentiation. (3) It was feasible to deploy the stent under MR guidance. Due to the prototype catheter size, we were unable to reintroduce the catheter into the stent lumen. We were successful, however, in using similar methods to guide a 5 Fr imaging catheter into the stent and to acquire rapid high resolution images from within the stent. There, we could delineate lumen (black arrow), catheter tip (white arrow), stent mesh (arrowhead) and surrounding tissue (Fig. 1b).

Conclusion: This study showed the feasibility of accessing the carotid artery with a combined imaging and stenting catheter in a pig model entirely under MR guidance. It also allowed acquisition of high resolution vessel wall images. With the 12F catheter size, medium-sized vessels such as the carotid artery can be catheterized without damaging the vessel wall as documented on gross pathological examination. Although we failed to reintroduce the same device into the stent, we were able to show that image acquisition from within the stent is feasible using the same type of catheter, provided it has an appropriate diameter. The capability to image within a stent and the opportunity to differentiate lumen from stent and surrounding tissue has not, to the best of our knowledge, been reported and may have a tremendous impact upon the understanding of post treatment course in patients with atherosclerotic disease. Follow up examinations at later time points will help to evaluate the in stent behavior of vascular structures.

Ref: **1.** Feng L, et al. *Radiology* 2005;234:558
2. Hillenbrand CM, et al. *JMRI* 2006;23:135.

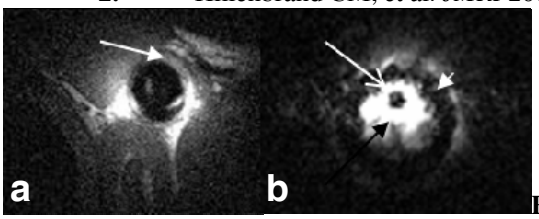

Fig. 1