

MR guided angioplasty of peripheral arteries: delivery of substances into the vessel wall

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Introduction

Sirolimus and paclitaxel coated stents are successfully used for prevention of in-stent restenosis. The restenosis rate has significantly improved but a risk of future complications remains. Due to the success of substance-coated stents, application of therapeutics at dilatation of stenosis is appealing prior to a decision to place a stent. If substances are delivered during fluoroscopy-guide angioplasty the concentration of delivered substance is difficult to assess. Accordingly, the aim of the current study was to develop a protocol for MR-guided angioplasty of stenosis in peripheral arteries combined with the delivery of substances and monitoring of the distribution of the solution within the vessel wall.

Methods

A 8 mm ballon catheter was-perforated using laser. Perforations were sized so that a flow of 60 μ l/min were achieved at 5.1 bar. In 3 pigs feasibility of delivery of substances to the vessel wall was tested. In these animals the ballon catheter was advanced through an introducer sheath (9F) in the carotid artery to the femoral arteries. The ballon catheter was inflated with a solution of 0.05mmol/ml Gd-DTPA and 3% Evans blue-dye under real time guidance. After the intervention a T1-weighted gradient-echo sequence was used to delineate the distribution of the substance. The size of the hyper-enhanced area and the signal intensity were measured.

In 5 animals bilateral stenosis in the external iliac artery was created by placing a suture around the vessels. In these animals the stenosis was dilated by inflating the ballon with the contrast-medium/tissue-dye solution. Prior and after dilatation a MR-angiography sequence (coronal T1-weighted gradient-echo sequence after intravenous injection of 0.2 mmol/ Gd-DTPA/ kg bodyweight, TR/TE 4.2/1.4ms, flip angle 30°, slice thickness 2.4 mm) and a T1-weighted gradient echo sequence (TR/TE 45/4.6ms; flip angle 35°, slice thickness 3 mm) were used. Postmortem, the vessels were excised and microscopically examined to identify possible injury of the vessels, such as dissection of the vessel wall and assess presence of blue-dye in the vessel wall.

Results

In all animals the ballon catheter could be guided to the target vessel using real-time MRI imaging. Inflation of the ballon was clearly visible in all animals. In the pigs without stenosis 3 cm³ of tissue could be stained with contrast agent. All 10 stenosis could be dilated in the 5 pigs using real-time guidance. T1-weighted gradient echo images showed the delivery of contrast medium to the vessel wall (Figure 1). No complications, such as retroperitoneal hematoma or dissection of vessels, were encountered during the intervention. Postmortem analysis confirmed these findings. Histology demonstrated distribution of blue-dye within the vessel wall.

Discussion

Angioplasty was successfully performed using real time MR imaging guidance. It was possible to deliver a contrast medium containing solution to the vessel wall and to delineate the distribution of the contrast medium within the vessel wall. The technique is a promising tool for delivery of therapeutics during dilatation of stenosis in peripheral arteries.

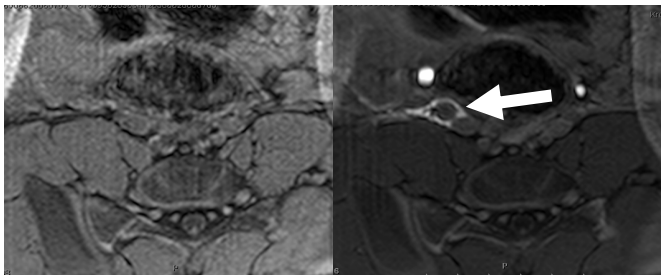


Figure 1: T1-weighted gradient-echo images prior (left) and after dilatation and application of the contrast-medium containing solution (right). The vessel wall is enhanced (arrow).

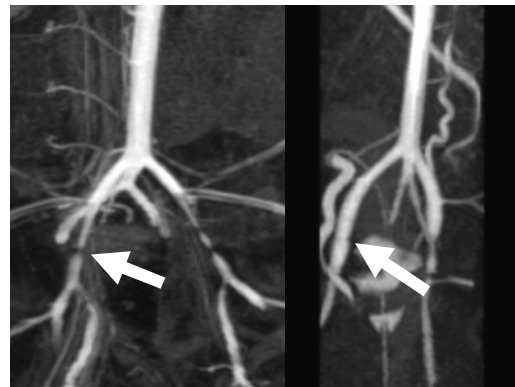


Figure 2: Maximum intensity images prior (left) and after dilatation. The stenosis (arrow left image) has successfully been treated (arrow, right image).