Reduction of CT Beam Hardening Artifacts of Ethylene-Vinyl Alcohol Copolymer by Variation of the Tantalum Content

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INTRODUCTION

As Onyx™ was initially approved for embolization of intracranial pathologies, its high tantalum content (TC) ensured fluoroscopic contrast despite the high x-ray absorption of the braincase. Tantalum, however, causes relevant beam hardening artifacts in CT examinations that might limit diagnostic information of any follow-up imaging. We developed an aortic phantom to simulate treatment and follow-up imaging of endoleaks, and assessed the diagnostic performance of Onyx™ liquid embolic system formulations with different, reduced TCs in order to determine a tantalum dosage that interferes less with diagnostic CT imaging, but still enables fluoroscopic visualization during embolization.

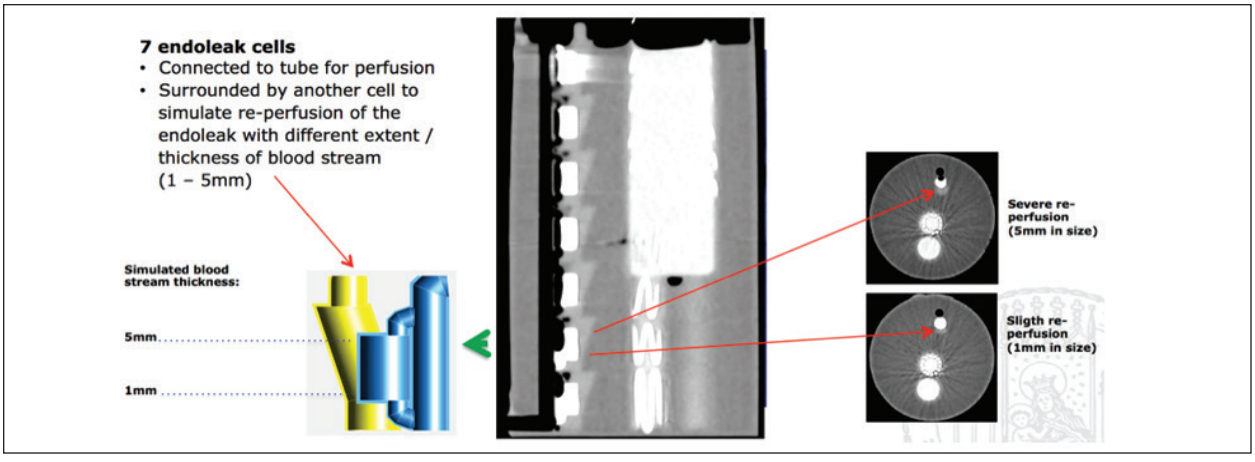

Figure 1. Phantom to simulate treatment and re-treatment of endoleaks after aortic stent grafting. A stent graft is placed in a central tube, surrounded by simulated thrombus, as it can be found in an aneurysm sac. Two tube systems with small cavities simulate the endoleak and the reperfusion of the endoleak with different severity.

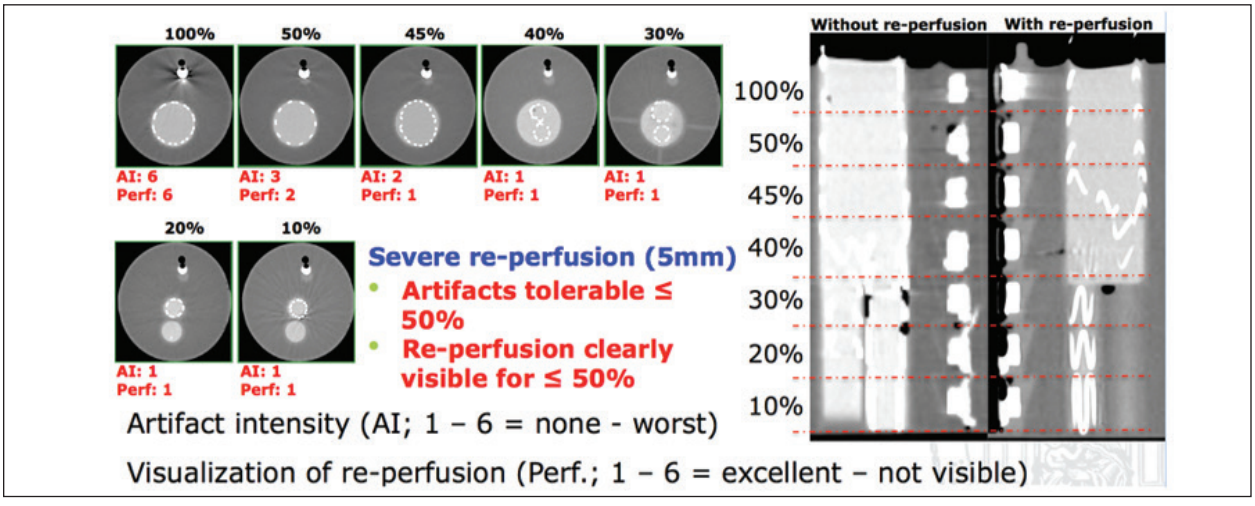

Figure 2. Artifact intensity and visualization of reperfusion after treatment of the simulated endoleaks with Onyx™ liquid embolic system with decreased tantalum content.

METHODS

Onyx™ liquid embolic system specimens of different TC (10%-50% and 100%) were injected in an aortic phantom bearing a stent graft and endoleak cavities with simulated reperfusion of different strength (1-mm and 5-mm wide rim of contrast surrounding a simulated endoleak, standing for slight and severe reperfusion) (Figure 1). Fluoroscopic visibility of the Onyx™ liquid embolic system specimens was analyzed. In addition, six radiologists analyzed endoleak visibility and artifact intensity of Onyx™ liquid embolic system in CT scans.

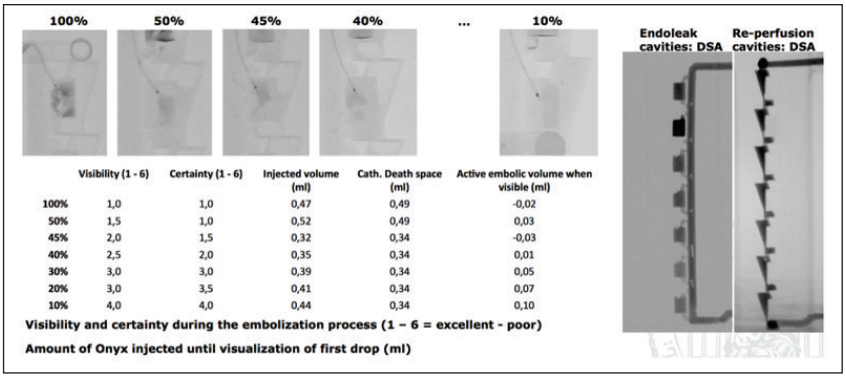

Figure 3. Fluoroscopic visualization of Onyx™ liquid embolic system with decreased tantalum content. The visualization of the first drop decreased, and the active embolic volumes increased consecutively, reaching intolerable volumes with a tantalum content of 30% and less of the original product.

RESULTS

Reduction of TC significantly decreased CT-artifact intensity of Onyx™ liquid embolic system and increased visibility of endoleak reperfusion ($P < .000$) (Figure 2). It also significantly decreased fluoroscopic visibility of Onyx™ liquid embolic system ($R \geq 0.883$; $P \leq .01$) and increased the active embolic volumes prior to visualization ($\Delta \geq 40$ µL) (Figure 3). Onyx™ liquid embolic system specimens with a TC of 45% to 50% exhibited reasonable visibility, a low active embolic volume, and a tolerable CT-artifact intensity.

CONCLUSIONS

Our data suggest a reduction of the TC of Onyx™ liquid embolic system to 45% to 50% of the original to interfere less with diagnostic imaging in follow-up CT examinations, but still allowing for fluoroscopic visualization. This may improve diagnostic accuracy of follow-up CT examinations and provides safe fluoroscopic control of the embolization process. ■

Presented at the 2012 RSNA annual meeting in Chicago, Illinois.