Introduction: Current aortic valve prosthesis comprise either glutaraldehyde preserved porcine valves that are sewed to a polyester fabric frame or mechanical valves comprising a metal ring and synthetic valve mechanisms. Percutaneous valve repair [1] makes use of balloon expanding stents with a bovine jugular vein valves for repair of the pulmonary artery [2] or self expanding (CoreValve) and balloon expanding stents with polymer valves [3]. During x-ray guided placement the positioning of the valve in the correct orientation and secure anchoring is difficult to achieve due to the lack of soft tissue contrast. The metal leads to susceptibility artifacts and RF shielding of the valves compromising diagnostic value of MRI. The purpose of this study was to improve visualization of a percutaneously implantable heart valve under MRI trough the use of a resonant circuit [4].

Material and methods: As the bioprosthetic valves show the best long-term clinical results we have selected these valves and a self expanding stent frame for the basic design. A porcine heart valve was dissected and sewed in to 24 mm x 40 mm. Nitinol stent (Memothem, Bard Angiomed Karlsruhe, Germany) with 4-0 Prolene (Ethicon) was used for the stent struts in a wave form to provide an appropriate quality factor and to facilitate fixation. It was sewn with a polyfilament 2-0 polyester thread to the stent struts in a wave form to achieve controlled compression and expansion whereby the resonator functions remains. This stent valve was tested in 1.5 T Siemens Sonata and Espree. The MR tests were performed in 1 liter distilled water with 0.9% NaCl at 21° Celsius ambient pressure in a Tupperware container (113mm x 113mm x 55mm). The container was placed in the standard head coil.

The heart valve was introduced into a 13mm (inner diameter) delivery tube that was attached to a disposable MRI compatible plastic trocar sleeve for the basic design. A porcine heart valve was dissected and sewed in to 24 mm x 40 mm. Nitinol stent (Memothem, Bard Angiomed Karlsruhe, Germany) with 4-0 Prolene (Ethicon) was used for the stent struts in a wave form to provide an appropriate quality factor and to facilitate fixation. It was sewn with a polyfilament 2-0 polyester thread to the stent struts in a wave form to achieve controlled compression and expansion whereby the resonator functions remains. This stent valve was tested in 1.5 T Siemens Sonata and Espree. The MR tests were performed in 1 liter distilled water with 0.9% NaCl at 21° Celsius ambient pressure in a Tupperware container (113mm x 113mm x 55mm). The container was placed in the standard head coil.

Results and Discussion:

The aortic valve could be approached with the delivery system and the expansion of the heart valve could be visualized with real-time MRI. There was a two-fold increase in signal of the resonant part of the stent. The RF shielding of the Nitinol stent could be overcome so that the substrate could be visualized using a flip angle of 20°. The signal increase facilitated MRI guided positioning. The results demonstrate that the use of a resonant structure on the stent based heart valve could minimize or avoid the negative shielding effects of the stent structure.

References