Percutaneous Balloon Aortic Valvuloplasty Under Real-time MRI Guidance

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Introduction

Percutaneous balloon aortic valvuloplasty (PBAV) has been used as an alternative to surgical valve replacement for patients with calcific aortic stenosis and to surgical valvulotomy for patients with congenital aortic stenosis[1]. Similar to other interventional cardiac procedures, balloon aortic valvuloplasty has been performed under x-ray fluoroscopy. By means of excellent soft tissue contrast, flow sensitivity, and more importantly, the advantage of no ionizing radiation, MRI has emerged as a potential powerful tool for the guidance of a variety of cardiovascular interventional procedures [2]. The aim of this study was to investigate the feasibility of conducting PBAV under real-time MR guidance using a conventional x-ray balloon catheter.

Material and Methods

Three farm pigs, 70-80 lbs, were used in this study. All experiments were performed under a protocol approved by our institutional animal care and use committee. The animal was anesthetized with an intramuscular injection of 6-10mg/kg tiletamine hydrochloride and zolazepam hydrochloride (Telazol, Fort Dodge Animal Health, Fort Dodge, IA). For maintenance, a solution of ketamine and xylazine was infused through an ear vein, and 1mg/kg zolazepam hydrochloride was added intramuscularly every 45-60 minutes. Femoral artery punctuation was conducted under ultrasound guidance, then a 9-14 F sheath was placed in the femoral artery. Then, 100 IU heparin per kg body weight was administrated as an intravascular bolus.

All experiments were conducted on a 1.5T MR system (Magnetom Sonata, Siemens Medical Solutions, Erlangen, Germany). The animals were placed in the MR scanner in a supine position. After acquisition of a localizer, two-dimensional axial and oblique True-FISP images (TR/TE/Tip/Thickness: 3.03ms/1.52ms/40°/5mm) were obtained to localize the aortic arch, the aortic root, and the left ventricle. The images were displayed on an in-room monitor adjacent to the magnet. Then, a real-time True-FISP sequence (TR/TE/Tip/Thickness: 2.33ms/1.17ms/40°/10mm; 3 frames/sec) was used to track the tip of the catheters. Percutaneous balloon aortic valvuloplasty was perfomed in 3 animals using a conventional x-ray balloon catheter manufactured by Cordis (Miami Lakes, FL). A steerable hydrophilic-coated guidewire (0.035-inch Radifocus, Terumo Tokyo, Japan) was coaxially inserted to advance the catheter. The intravascular devices were visualized by means of their native susceptibility artifacts. Non-diluted Gadolinium-DTPA was used to inflate the balloon through a 20ml syringe. The balloon was partially inflated to enhance the visibility of the balloon catheter before reaching the aortic valve. The balloon was fully inflated when it reached the level of the aortic valve, thereby completing the aortic valvuloplasty.

Results

Percutaneous aortic balloon valvuloplasty was successfully performed on all 3 animals. The location of the tips of the guidewire and balloon were well defined throughout the procedure. Once introduced into the vessel lumen, the balloon catheter was easily tracked over the wire by observing the Gadolinium-DTPA induced signal void from the partially inflated balloon. No complications related to the interventional procedure were observed.

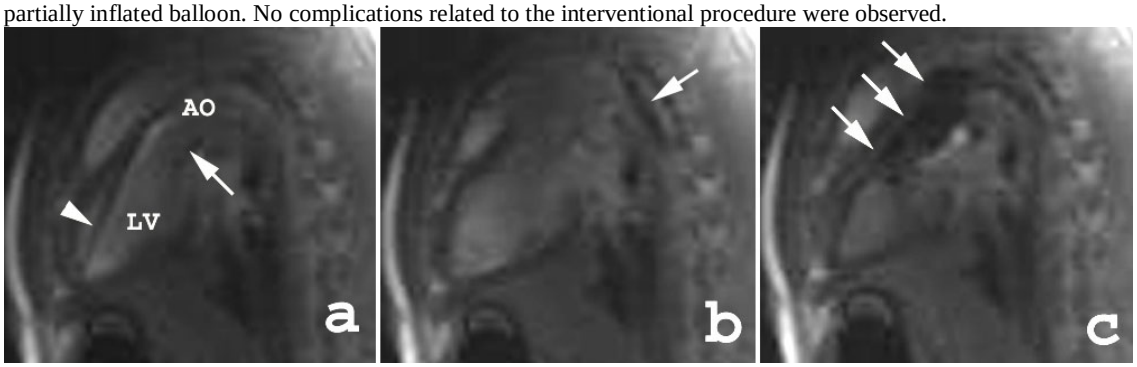

Figure 1. a: arrowhead-the guidewire tip in left ventricle (LV), arrow-the location of aortic valve, AO-ascending aorta; b: arrow-partially inflated balloon in descending aorta; c: triple arrows indicate fully inflated balloon at aortic valve

Discussion and conclusion

While interventional MR procedures have been described since the late 1980s, MR guidance for cardiovascular intervention has only emerged within the last couple of years. Here, we found that both guidewires and balloon catheters (Cordis product in this study) are easily tracked under real-time MR guidance. One advantage of real-time MRI guidance demonstrated here is that the precise location of the aortic valve can be identified continuously during the procedure without injection of a contrast agent. Significant improvement of both MR hardware and MR pulse sequences has created the potential, for MR guidance to open a new era for cardiovascular interventions. In conclusion, PBAV under real-time MR guidance with a conventional x-ray balloon catheter is feasible.

Reference

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