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COMMENTARY

Editorial comment

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In this issue of the Journal, two papers deal with improved imaging for planning and guidance of transcatheter aortic valve implantation using intraoperative rotational angiography a technique that was pioneered by Kempfert in 2009 [1]. Numburi et al. [2] report an experimental study to optimize the acquisition and contrast Injection protocol for C-arm CT Imaging. In principle, intraoperative rotational angiography is performed to reconstruct a 3-dimensional image of the aortic root. After contrast injection into the aortic root sequential frames are collected while the detector rotates around the patient. From the segmented images, a 3D reconstruction can be performed. For further planning, templates of implants can be virtually placed into the reconstructed root to assist valve selection [3] and the 3D reconstruction can be used to determine optimal angiographic projections. As opposed to using a preoperative CT scan of the aortic root, registering is not necessary, as the position of the aortic root remains unchanged. Overlay of the 3D reconstruction with fluoroscopy is therefore easily achieved but is currently of limited value due to the lack of motion compensation and hence significant inaccuracies due to motion artifacts. The reconstructed 3D-images are currently not synchronized with the beating heart and therefore a significant registration error may occur throughout the cardiac cycle. One obvious solution is to track the aortic root by native markers such as leaflet calcifications or endovascular markers such as the Pigtail catheter that is used during the intervention. These algorithms are currently under investigation [4, 5].

Numburi et al. compared 5 protocols for obtaining the best image quality for intraoperative 3D reconstruction in an attempt to limit the additional need for contrast, and obviate the need for rapid ventricular pacing during image acquisition. While all images acquired during SR (both with peripheral and aortic root injection and with or without ECG gating) produced mild to moderate artifacts, only rapid pacing during image acquisition yielded optimal results. This finding does not come as a surprise since dye in the aortic root is rapidly diluted when the heart is ejecting and thus image contrast is impaired. In addition the aortic root is in motion when the heart is beating, hence motion artifacts are almost unavoidable, despite ECG gating. Therefore, when the method was established in 2009, direct root injection using diluted dye under rapid pacing was found to produce the best image quality [1]. This method has the additional advantage that co-registration of the 2D-live fluoroscopy image during implantation (which is usually done under rapid ventricular pacing) with the 3D reconstruction (also performed under rapid ventricular pacing) has less registration error.

Lehmkuhl et al. [5] in the same issue of the Journal compare the geometric accuracy of aortic root measurements obtained by intraoperative three-Dimensional rotational angiography to preoperative contrast enhanced ECG gated multislice computed tomography (MSCT). In 27 patients the diameter and size of the aortic annulus, the distance to the coronary ostia and diameters of the aortic root and the thoracic aorta were measured. As a principal finding, all measurements were within two standard deviations, with higher correlation for supra-annular dimensions. Sizing of the aortic annulus revealed lower interobserver variability for MSCT than for three-dimensional rotational angiography which led the authors to the conclusion, that MSCT is more reliable when it comes to determine annular size which is the basis for valve selection.

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It is to mention that results of measurements of MSCT should be compared to rotational angiography in diastole (aortic valve closed) since rotational angiography is performed in the non-physiological state of high-output failure induced by rapid ventricular pacing (aortic valve closed due to low left ventricular pressure). Since the aortic annulus despite calcification remains a dynamic structure, comparison between systolic annular dimensions in MSCT with rotational angiography are therefore of limited value. Similarly, rapid ventricular pacing leads to a drop of blood pressure and a lack of pulsatile expansion of the aorta which is usually present throughout the cardiac cycle. Comparisons of aortic dimensions must take this limitation into account.

The authors correctly discuss the limitations of the current method for rotational angiography which may explain the higher interobserver variability when it comes to sizing of the annulus: the lack of visualization of the left ventricular outflow tract, which greatly complicates accurate measurements of the annulus. Therefore the authors raise a word of caution in that it may be too early to base valve size selection on intraoperative rotational angiography rather than on MSCT imaging. In order to reliably visualize and measure the aortic annulus with 3D-RA, new injection protocols other than supra-annular application (some of which were examined by Numburi [2]) may be required.

The main advantages of 3D-trotational angiography during transcatheter valve procedures as it is currently applied may therefore be (1) calculation of the optimal angulation of the C-arm (2) correct positioning of the valve (provided registration of overlay is correct) and (3) avoidance of repetitive contrast medium application. In combination with transesophageal echocardiography, that is commonly used for annular sizing and valve selection rotational angiography may obviate the need for preoperative MSCT in the future.

Conflict of interest I have no conflicts of interest with regards to this manuscript.

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