Time-Resolved MR Angiography Pre-Catheter-Based Ablation for Atrial Fibrillation

M. Schonberger[1], A. Usman[1], A. Kino[1], A. Popescu[1], M. Galizia[1], J. Collins[1], J. Carr[1], and T. Carroll[1]
[1]Department of Radiology, Northwestern University, Chicago, Illinois, United States

Objective: The purpose of this study was to evaluate Time-resolved MR angiography (TR-MRA) of the pulmonary venous circulation using the time-resolved angiography with interleaved stochastic trajectories (TWIST) method and compare it with the more commonly used conventional contrast enhanced magnetic resonance angiography (CE-MRA) approach in atrial fibrillation patients referred for pre-ablation pulmonary vein mapping.
Background: Catheter-based ablation of the pulmonary veins prevents recurrence of atrial fibrillation in 70-80% of patients during the first year of follow-up[1,2]. CE-MRA depicts the left atrium and pulmonary veins with high spatial resolution, enabling accurate measurement of pulmonary vein ostia to be made with depiction of their relationship to other structures.[1,3] Conventional CE-MRA however requires timing of contrast enhancement and produces images with overlap of venous and arterial structures, potentially obscuring pulmonary vein ostia. TR-MRA is an alternative to conventional CE-MRA and has been used successfully in many other vascular territories.[4] Such an approach may be particularly advantageous in the pulmonary circulation with its rapid arteriovenous transit time, allowing acquisition of pure pulmonary venous phase images with a simpler imaging protocol.
Material and Methods: 26 patients (15 males; age 60.0 ± 12.7y) referred for pre-ablation pulmonary vein mapping underwent both conventional CE-MRA and TR-MRA with TWIST. Imaging was performed on a 1.5 Tesla (MAGNETOM Avanto, Siemens Healthcare) MRI scanner. Source partition and MIP images were evaluated. ***Quantitative Analysis:*** Pulmonary vein ostium orthogonal dimensions were measured using double oblique multiplanar reformatting. Bland-Altman analysis and Pearson analysis revealed close correlation between TWIST and CE-MRA techniques (Fig 1,2). ***Qualitative* Analysis:** For qualitative analysis, both source partition images and MIP images were assessed by two observers (AP & MG). The number of pulmonary veins (3 veins= common ostium, 4 veins = normal, 5 veins=accessory vein) was recorded (Fig 3). Pulmonary vein conspicuity was scored on a scale of 1-4 (1=poor, 2=fair, 3=good, 4=excellent (Fig 4).
Results: Orthogonal venous diameters were comparable for both TR-MRA and conventional CE-MRA (1.34cm ± 0.37 vs 1.38cm ± 0.36, respectively); see Figure 1, 2. Visualization of pulmonary vein anatomy and variant anatomy was also similar for both techniques (fig 3). Conspicuity scores for each pulmonary vein were also similar for both techniques (fig 4). Inter-rater reliability between observers was also comparable for both techniques.
Conclusion: We have demonstrated that TR-MRA using TWIST produces comparable anatomic images and pulmonary venous dimensions to the more widely used CE-MRA technique. TR-MRA improves arterio-venous separation producing high resolution pulmonary venous phase images without arterial overlap.

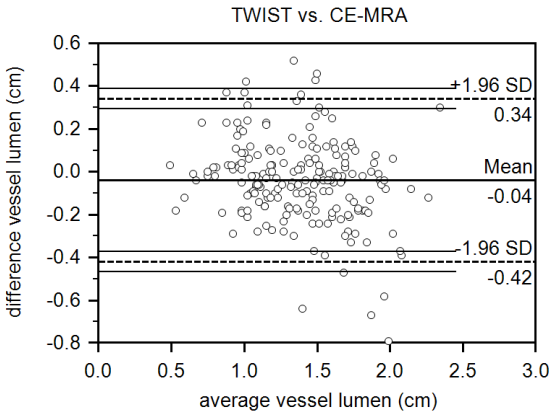

Figure 1: *Comparison of vessel lumen dimensions using Bland-Altman analysis to quantify agreement between conventional CE-MRA and TWIST (time-resolved) MRA. Estimation of precision of the limits of agreement (defined as mean ± 1.96 SD) was based on calculation of 95% confidence intervals (solid line).*

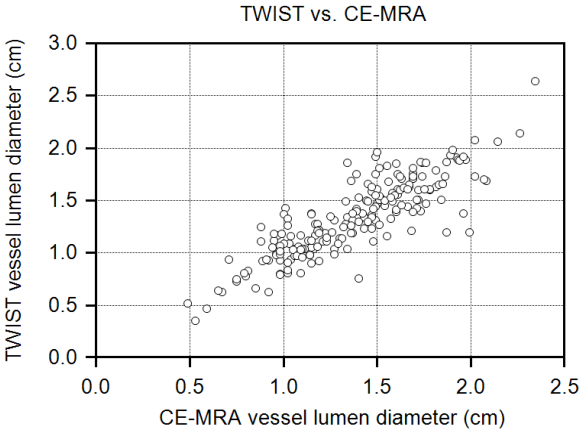

Figure 2: *Comparison of vessel lumen dimensions using Pearson analysis to quantify agreement between conventional CE-MRA and TWIST (time-resolved) MRA. The Concordance correlation coefficient is 0.8522, and the Bias correction factor is 0.9941.*

References:
1.Hauser TH et al. *Europace*. 2008
2. Wattigney WA et al. *Circulation*. 2003
3. Maksimović R et al. *European Radiology*. 2006
4. Kim CY et al. *AJR* 2008

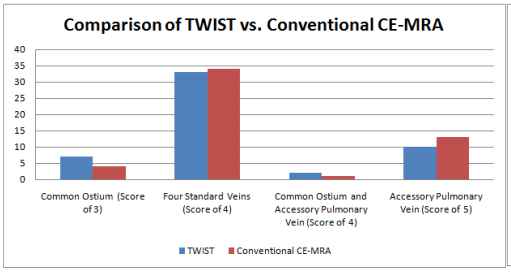

Figure 3: *Comparison of accessory vein and common ostium measuring ability using a bar graph to quantify differences between TWIST TR-MRA and conventional CE-MRA*

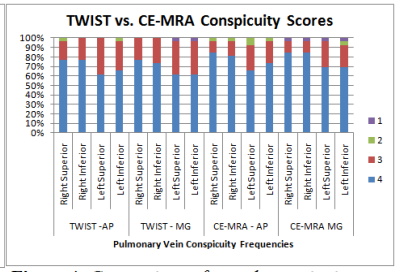

Figure 4: *Comparison of vessel conspicuity frequencies categorized by observer and protocol. The Inter-rater reliability percentage via weighed Kappa test was 76.1% ± 6.6% with a confidence interval of 63.1-89.1% for TWIST and 78.4% ± 5.3% with a confidence interval of 68.1-88.8% for CE-MRA.*