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Correlation between cardiac catheterization and contrast enhanced MRI in pulmonary artery stenosis

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Introduction

Peripheral pulmonary artery stenosis (PPAS) is present in 2-3% of all congenital heart defects. Catheter interventions guided by conventional X-ray angiography (XRA) have replaced cardiac surgery in the management of PPAS. However, X-ray exposure has negative health effects. Interventional XRA would benefit from non-ionizing and non-invasive planning using contrast enhanced magnetic resonance imaging (CE-MRI) due to its multi-planar capability, but the correlation of images in the two modalities is not always perfect, possibly due to different projections or time delays in capture.

Purpose

The goal of this study was to evaluate the correlation between XRA and CE-MRI in patients with pulmonary artery stenosis. The first hypothesis is that CE-MRI measurements of PPAS with the same angulations used in XRA ($CE\text{-}MRI_{XRA}$) correlate well with XRA measurements. The second hypothesis is that there is a change in correlation if CE-MRI is performed using the conventional cross-sectional view of the vessel ($CE\text{-}MRI_{cross}$) compared with XRA.

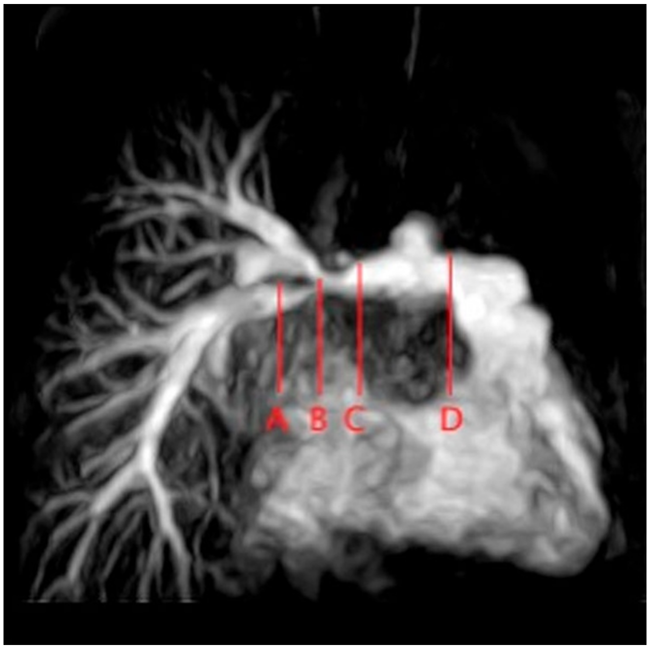

Figure 1
MRI-CE showing right pulmonary artery stenosis. A = Pulmonary artery site 1 cm distal to the stenosis. B = Pulmonary artery stenosis site. C = Pulmonary artery site 1 cm proximal to the stenosis. D = Pulmonary artery bifurcation site.

Methods

Retrospectively, cineangiograms were reviewed by two experienced XRA observers, CE-MRI images were reviewed by one experienced MRI observer in 13 patients with pulmonary artery stenosis who had undergone both proce-

Table 1: Median and ranges expressed in mm. of every observer (columns) and the difference measurements perfomed in each localization (rows). Statistic differences between the difference techniques measurements (rows) in the difference localizations (rows) expressed as p value.

	Mean and (ranges) in mm				**p value**			
	XRA_{Obs1}	**XRA_{Obs2}**	**MRI_{XRA}**	**MRI_{Cross}**	**XRA_{Obs1} Vs XRA_{Obs2}**	**MRI_{XRA} Vs XRA**	**MRI_{Cross} Vs XRA**	**MRI_{XRA}Vs MRI_{Cross}**
Pulmonary artery stenosis	5.03 (2.3-14.2)	4.75 (2.2-13.3)	5.43 (2.8-18.1)	4.68 (2.1-15	0.060	0.221	0.565	0.051
Vessel diameter 1 cm distal to the stenosis	7.83 (2.1-19.7)	7.6 (2.2-18.7)	5.57 (3.4-10.6)	4.99 (3.0-7.3)	0.202	0.232	0.085	0.328
Vessel diameter 1 cm proximal to the stenosis	5.03 (2.3-14.2)	4.75 (2.2-13.3)	5.43 (2.8-18.1)	4.68 (2.1-15)	0.930	0.304	0.507	0.920
Distance from bifurcation to stenosis	13.58)5.1-30.9)	13.35 (2.9-29.7)	14.4 (2.0-45.0)	14.11 (2.1-45.0)	0.556	0.238	0.476	0.488

dures (Table 1). The diameter of the pulmonary artery stenosis and the vessels proximal and distal to the stenosis, and the distance from the stenosis to the bifurcation, was compared (Fig. 1) using the following imaging modalities: XRA(Fig. 2A), CE-MRI using the angulations used during XRA (CE-MRI_{XRA}) (Fig. 2B) and CE-MRI in standard cross-sectional views projections(CE-MRI_{cross}) (Fig. 2C). Because there was a time-delay between the procedures in most of the patients, measurements were adjusted to the body surface area (BSA).

Results

There was good correlation (T-test paired, p < 0,005) between XRA, CE-MRI_{XRA} and CE-MRI_{cross} (Table 1) for the diameter of the pulmonary artery stenosis and the vessels proximal and distal to the stenosis, and for the distance from the stenosis to the bifurcation (Figure 3). CE-MRI_{cross} tend to overestimate the stenosis. The correlation was not affected if the measurements were adjusted to the BSA.

Conclusion

CE-MRI is a valuable tool for planning interventions for pulmonary artery stenosis. CE-MRI_{cross} is not only a more accurate technique for measuring the diameter of the vessel, compared with the oblique angulations used in XRA, but it also provides two diameters of the vessel. This could be useful for future studies and standard measurements in which the stent size could be chosen according to the cross sectional area of the vessel rather than the minimal diameter acquired in only one XRA projection.

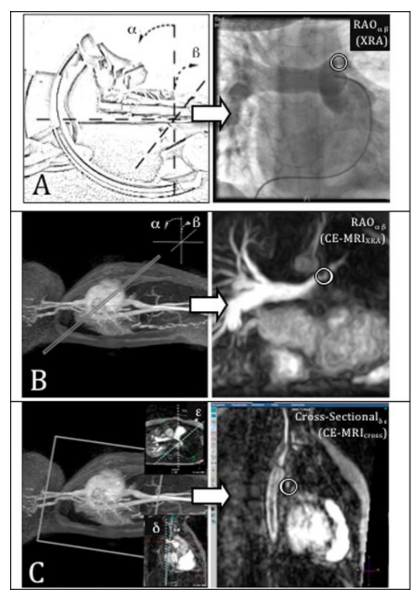

Figure 2

Visualization of the left pulmonary artery stenosis (pointed inside the circle) using the three different imaging modalities. A. Catheterization table shown in the left. Cranial (α) and left-rght (β) angulations are used to acquire the RAO projection shown in the right (XRA). **B**. The MRI data-set volume is reformatted using the same cranial (α) and left-rghti (β) angulations to acquire the RAO plane, shown in the right (CE-MRI_{XRA}). **C**. The MRI data-set is reformatted using different cranial (δ) and left-reight (ε) angulations to acquire a cross-sectional area of the vessel, shown in the right (CE-MRI_{cross}).

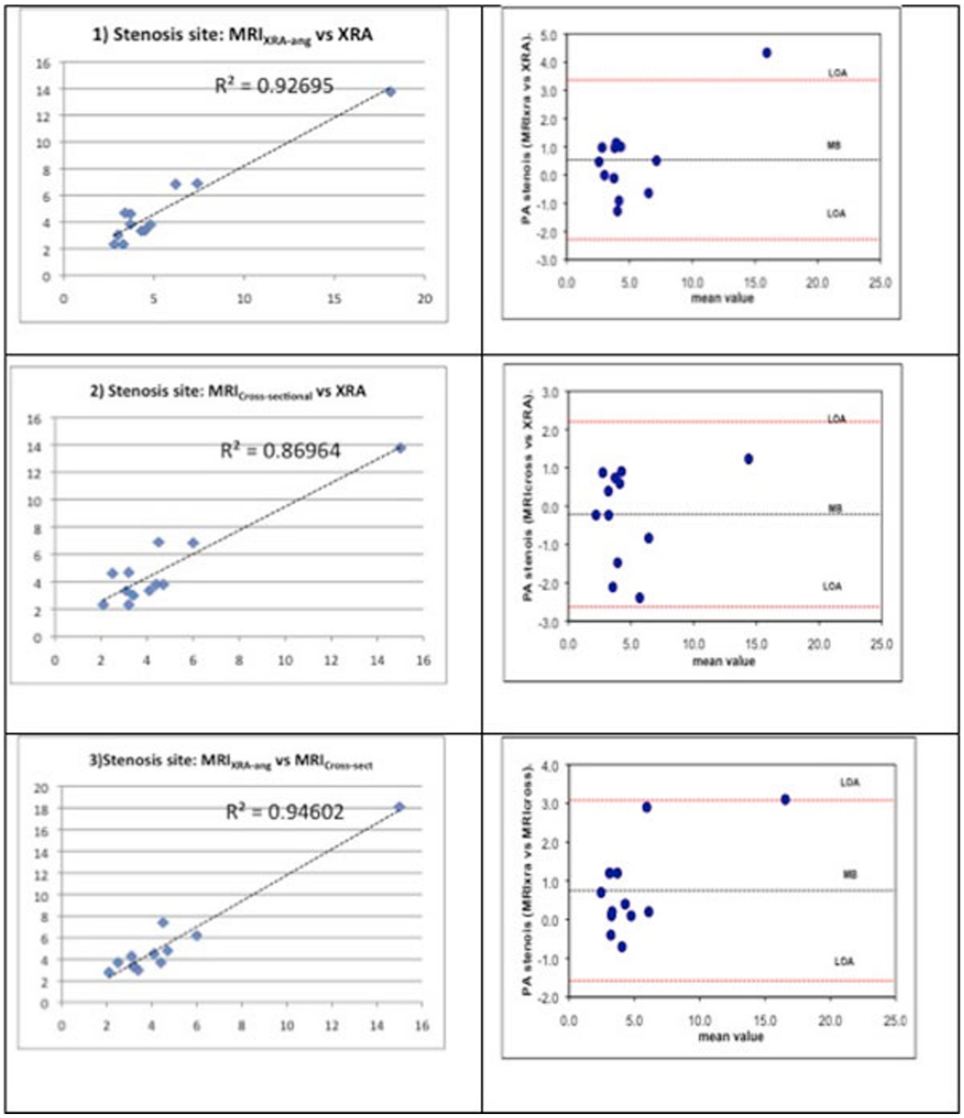

Figure 3

XY Scatter chart scaled in mm shown in the left column (Trend line correlation expressed as R^2). Bland Altman Plot shown in the right column. In the first row are shown the MRI measurements using XRA angulations (MRI$_{XRA\text{-}angulation}$) versus XRA measurements in the pulmonary artery stenosis site (1). In the second row are shown the MRI measurements using cross sectional angulations (MRI$_{cross\text{-}sectiona}$l) versus XRA measurements in the pulmonary artery stenosis site (2). In the third row are shown the MR$_{IXRA\text{-}angulation}$ measurements versus MRI$_{cross\text{-}sectional}$ in the pulmonary artery stenosis site (3).