

Statistical and Image Processing Tools for Predicting Severity of Calcific Degenerative Aortic Valve Stenosis

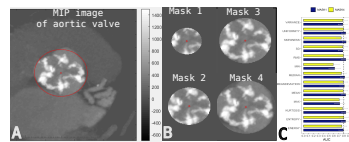
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Introduction: Features of calcific leaflet distribution from CT valve images may allow prediction of hemodynamic disease severity in calcific degenerative aortic valve stenosis (DAS). We describe image processing for determining disease severity in a population of 95 prospectively enrolled patients with DAS.

Method: (52+43) patient images were acquired, respectively diagnosed as having severe and moderate DAS, using a 320-multidetector CT with low-dose contrast (0.5ml/kg). A 10 mm maximum intensity projection (MIP) was created for the leaflet cross-section, including the entire leaflet depth (Figure A).

Image processing was implemented in Matlab 8.3, designed to accommodate variations in valve size that exist within the population: (i) Approximate the valve circumference with a circle (area A) by manual definition of the center point and radius, r ;



(ii) Apply eight masks, which define the pixels to be analyzed: Masks 1 to 4 are circular regions, each centered on the manually defined center point but with different fractions of A (Figure B), masks 5 to 7 are intersections of masks 1 to 4, and mask 8 the periphery of mask 1. The radii of circles in masks 1 to 4, are given by $\frac{r}{2}$, $\frac{r\sqrt{2}}{2}$, $\frac{\sqrt{3}}{2}r$, r respectively. Analysis of pixel intensities in each region was performed using the R environment package Radiomics. First order statistical features (FOFs), as listed in Figure C, were computed and analyzed across the 8 masks.

Mask:	1	2	3	4	5	6	7	8
Area:	$\frac{1}{4}A$	$\frac{1}{2}A$	$\frac{3}{4}A$	A	$1 \cap 2$	$2 \cap 3$	$3 \cap 4$	$4 \cap 1^C$

Results: The best FOFs for predicting DAS are skewness (AUC = 0.844) and kurtosis (AUC = 0.840) applied to mask 1. Cases of moderate DAS tend to have a histogram composed of a central tendency, while in more severe cases the distribution is dispersed and flattened towards higher attenuation. Statistical analysis of calcific leaflet distribution from CT valve images is able to predict hemodynamic disease severity in DAS, with the valve center seen as the most important region, an observation which is paralleled in the literature.