Aortic stenosis analysis using a novel fully automatic AI powered toolbox

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Background and significance

- Aortic valve stenosis (AS) is the most prevalent valvular heart disease in developed countries.
- Surgical aortic valve replacement (SAVR) is increasingly complemented by transcatheter aortic valve implantation (TAVI).
- Clinical events are associated with the design of prosthetic valves and interventional guidelines
- Fully automatic tool developed to explore calcium burden AND distribution in raw images to connect the morphology to the outcome

Methods

- CT images through internal IRB to secure raw images for >100 AS patients in DICOM format.
- Accumulative representation of calcification projections extracted for each case.

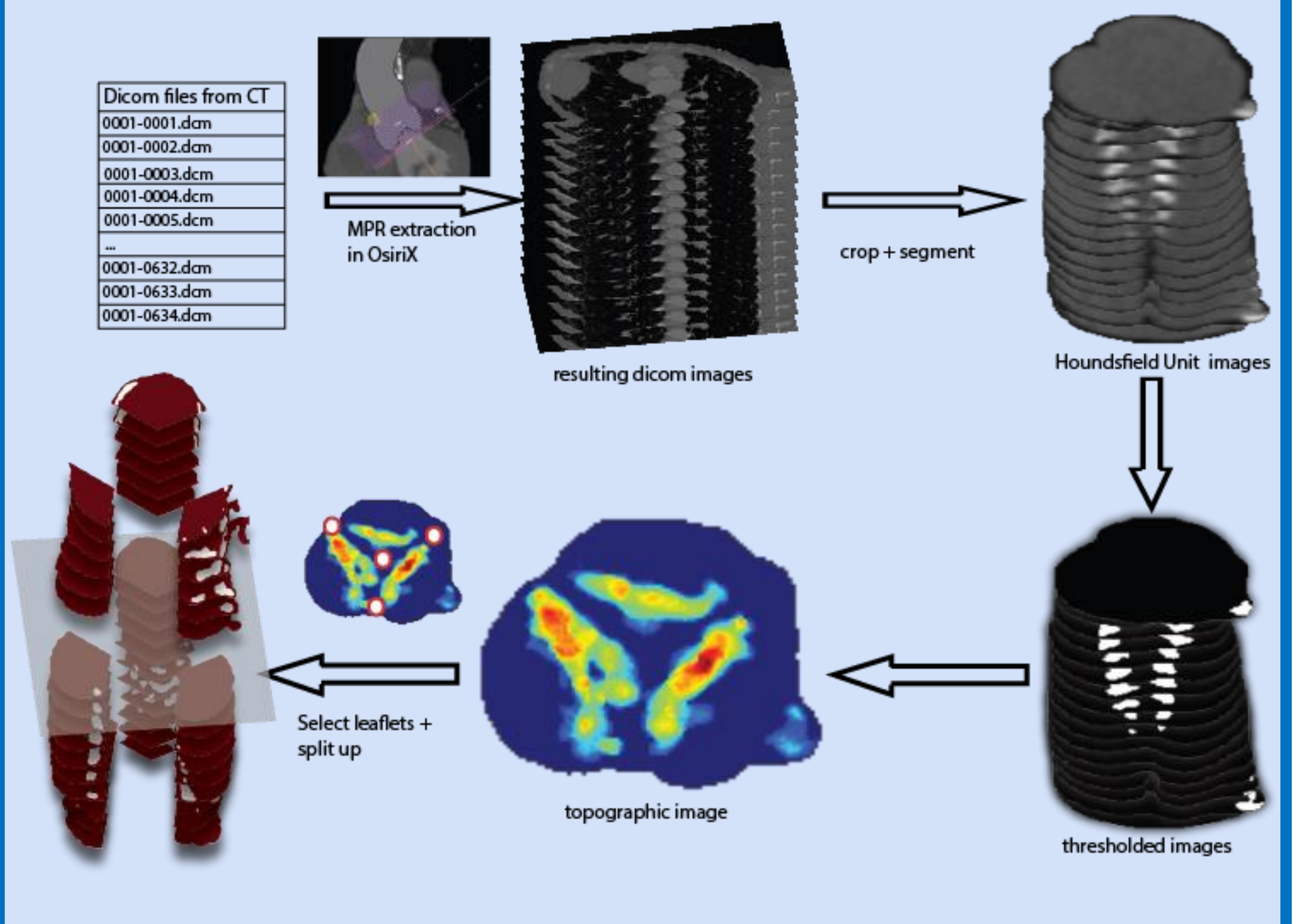


Fig.1: Flowchart representation of calculating calcification distribution on a heart valve from the raw DICOM images.

Results

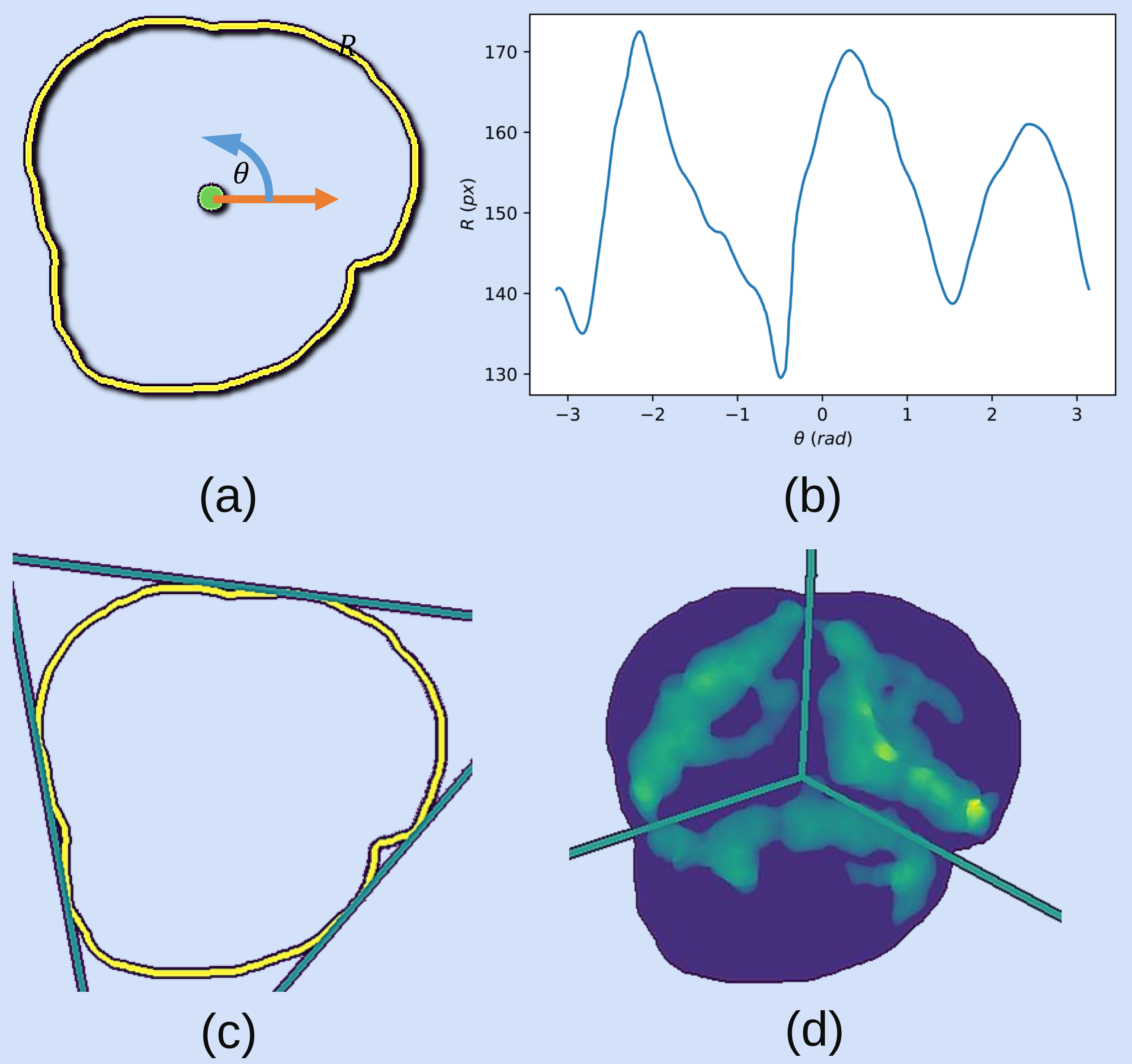


Fig.2: (a) Detected area centroid is used to convert to polar coordinate; (b) Local radios minima plotted to identify the preliminary candidates for commissures; (c) A novel method of minimum enclosed triangle is applied to assist listing final commissure points; (d) the three local minima closest to the middle of enclosed triangle edges are selected to identify individual leaflets.

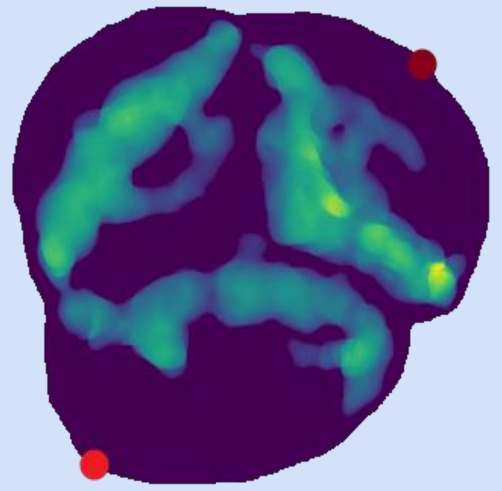


Fig.3: Location of coronaries are extracted from the raw DICOM images (left and right coronaries spotted by dark and light red circles) to identify coronary vs non-coronary cusps.

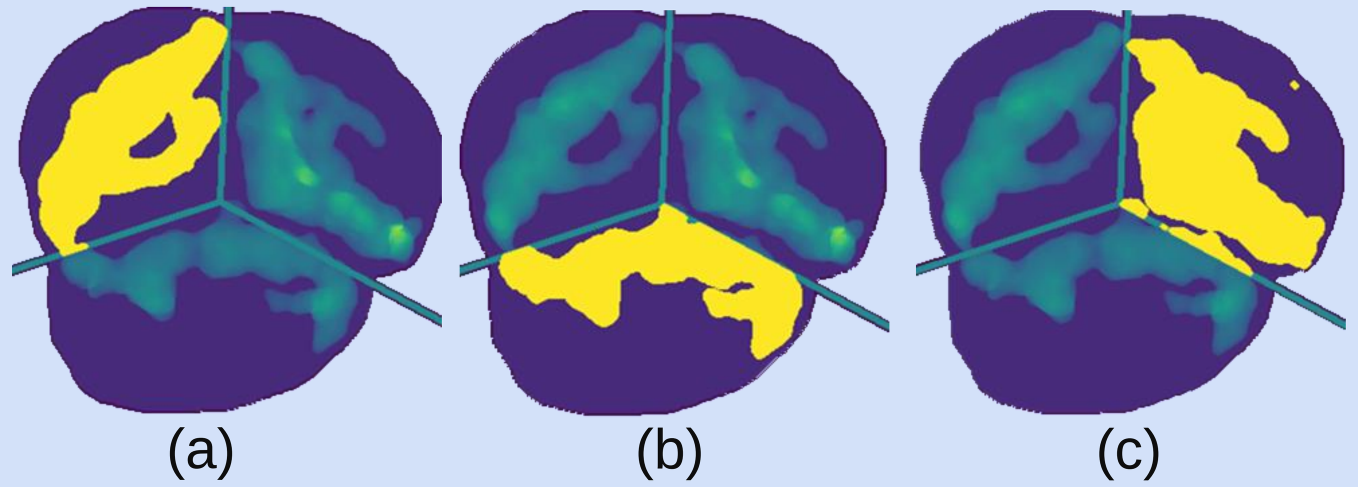


Fig.4: Automatic segmentation of cusps and calcifications for individual leaflets. (a) Non-coronary cusp; (b) Right coronary cusp; (c)Left coronary cusp

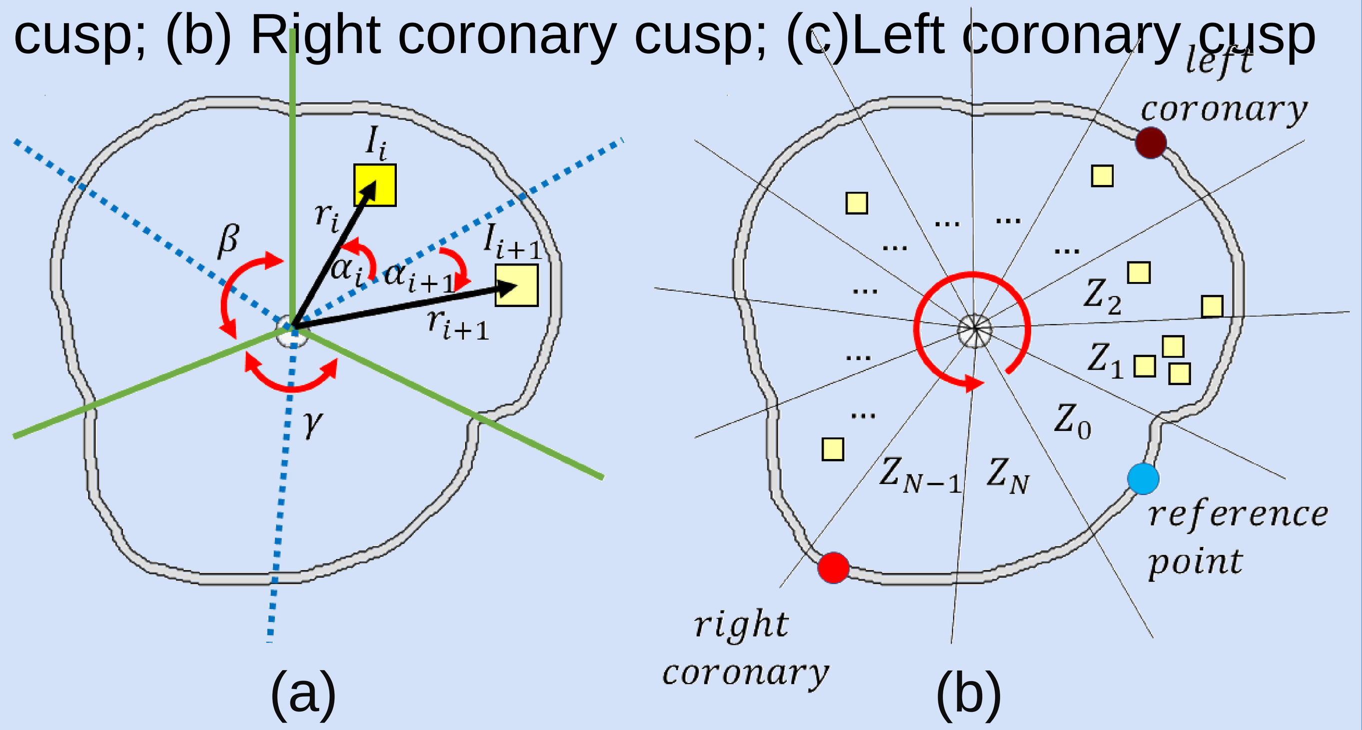


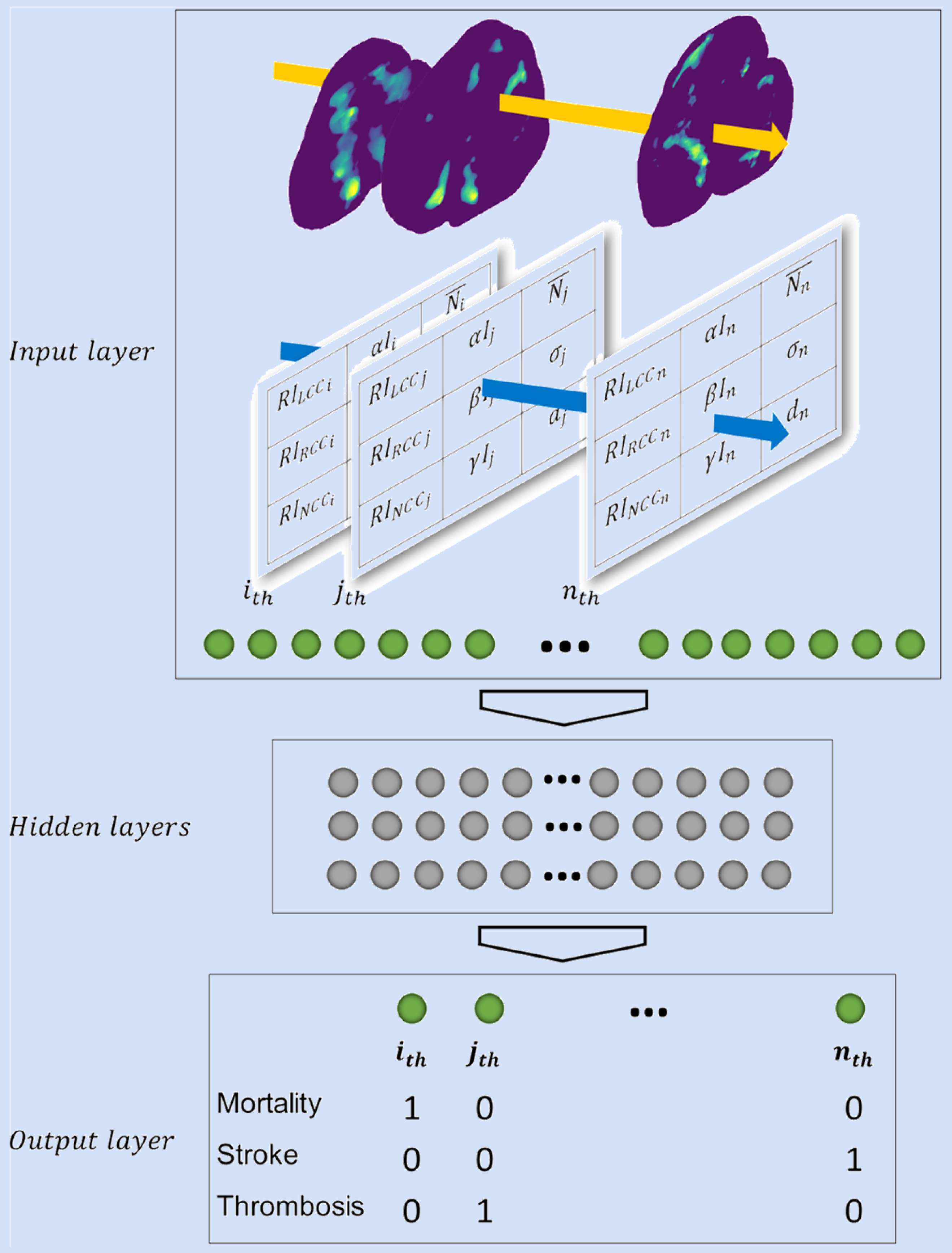
Fig.5: (a) Calcium distribution quantification on each cusp using two non dimensional numbers: Angular index showing how disperse calcification is from the bisect and Radial index representing the distance from the center of the valve; (b) Total angular distribution histogram is calculated relative to the reference point

Table 1: Prototypical radial and angular indices calculated for the representative sample in Fig. 3

	LCC	RCC	NCC
Radial	0.204	0.213	0.119
Angular	0.181	0.178	0.148

Indices are obtained for Left coronary cuspid (LCC), right coronary cuspid (RCC), and non-coronary cuspid (NCC)

AI-powered post processing



Conclusion

- Fully automatic algorithm developed to detect the patient-specific morphology of sinus and valve landmarks to extract the morphology of calcification in terms of burden and distribution
- AI-guided approaches offer unique potential to update guidelines and enhance clinical decision.

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