The Future of Myocardial Infarction Prevention: New Approaches to Quantifying Atherosclerotic Plaque Burden Beyond Coronary Artery Stenosis

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

Hufsa Khan, BS[1**], Kopal Bansal, MS[1**], Catherine Cantlay, BS[1], Alfateh Sidahmed, MD[1], Nick Nurmohamed, MD[1], Robert K. Zeman, MD[1], Richard J. Katz, MD[2], James P. Earls, MD[1], Andrew D. Choi, MD[2,3]

[1]Division of Cardiology, The George Washington University School of Medicine, [2]Department of Radiology, The George Washington University School of Medicine, Washington, DC, [3]Cleerly Healthcare, Denver, CO
(**Co-lead authors)

INTRODUCTION

- Heart disease is the leading cause of death both in the U.S. and worldwide, causing one of every five deaths in America.
- Current methods to categorize coronary arterial stenosis using cardiac CT angiography (CCTA) are provided by CAD-RADS 2.0 and include coronary artery calcium score (CACS), segment involvement score (SIS), or visual assessment of overall CAD burden.
- Limitations of these methods include subjective assessment, inter-reader variability, and lack of consistency in performing these measurements with every CCTA study.
- Artificial intelligence guided quantitative computed tomography (AI-QCT) may allow for a more quantitative, sensitive, and standardized approach to categorizing atherosclerotic disease burden, which could allow for preventive care intervention to reduce the incidence of acute cardiac events.

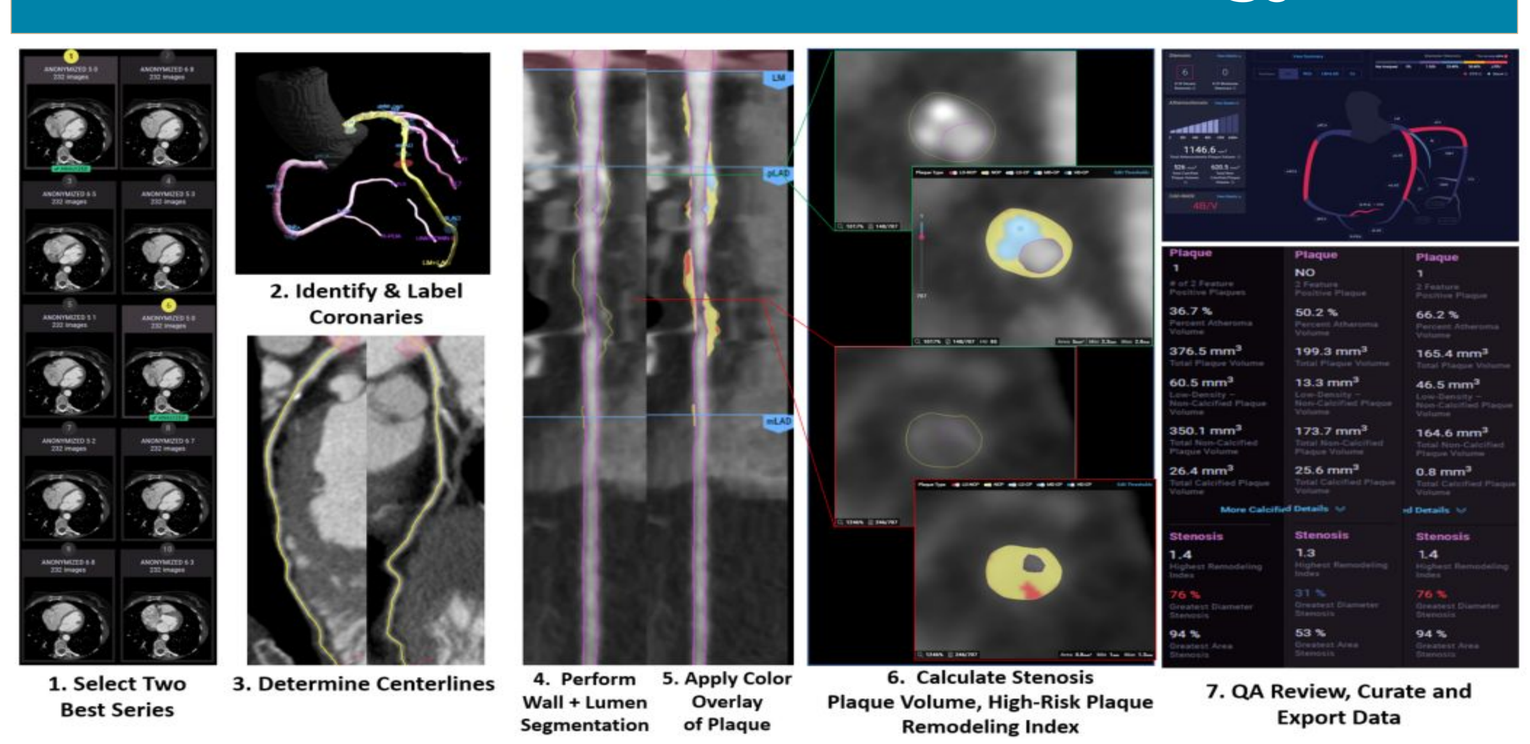
HYPOTHESIS

- This study compares AI-QCT plaque volume staging with currently used clinical methods of plaque assessment, including SIS, visual plaque estimate, CAD-RADS % stenosis category, and CACS. It is hypothesized that AI-QCT plaque volume staging will demonstrate moderate to high agreement with these clinical methods of plaque assessment.

METHODS

- CLARIFY study patients undergoing CCTA for chest pain were evaluated. A blinded core laboratory analyzed the CCTA studies via FDA-cleared AI-QCT software (Cleerly, Denver, CO) that stages plaque volume by prognostic thresholds (10 mm^3, 11-250 mm^3, >250-750mm^3 and >750mm^3). The AI-QCT staging was compared with clinical plaque evaluation methods: SIS (0, 1-4, 5-7, ≥8), visual plaque estimate (None, Mild, Moderate, Severe), CAD-RADS % stenosis category (0, 1-2, 3, 4-5), and CACS (0, 1-100, 101-300, >300), as evaluated by expert consensus visual assessment that was blinded to the AI-QCT core lab reads.

FIGURE 1: AI-QCT Methodology



Artificial Intelligence Quantitative Computed Tomography **(AI-QCT)** demonstrated **high agreement with SIS** for plaque burden categorization, but modest agreement to CACS, visual assessment or CAD-RADS % stenosis categories.

AI-QCT identifies total plaque volume of calcified and non-calcified plaque and **may enable a rapid, quantitative approach** to CAD categorical assessment beyond time-consuming visual or SIS-based approaches.

TABLE 1. Coronary Atherosclerotic Plaque Burden Stage Definition

CAD Stage Description	TPV (mm^3)	PAV (%)
Stage 0: No Plaque	0	0
Stage 1: Mild Plaque	>0–250 mm^3	>0–5%
Stage 2: Moderate Plaque	>250–750 mm^3	>5–15%
Stage 3: Severe Plaque	>750 mm^3	>15%

TABLE 2. Contingency Table of SIS vs AI-QCT Plaque Volume

N = 102		AI-QCT Plaque Volume Category			
		0-10 mm^3	11-250 mm^3	250-750 mm^3	>750 mm^3
Segment Involvement Score (SIS)	0	29	8	0	0
	1-4	0	52	0	0
	5-7	0	0	12	0
	>=8	0	0	0	4

SIS vs AI-QCT
Overall Agreement =93%
K=0.87 (0.79-0.96)

Contingency Table of SIS vs AI-QCT Plaque Volume.
In comparing AI-QCT whole heart plaque quantification to SIS, there was high agreement (93%; k= 0.87 [95% CI: 0.79-0.96]). The AI-QCT was more sensitive to mild plaque burden (P1) than visual assessment of SIS by independent readers.

CLARIFY Original Study (Choi AD, et al. JCCT)

For more information:
email
adchoi@gwu.edu
or on social media
@AChoiHeart

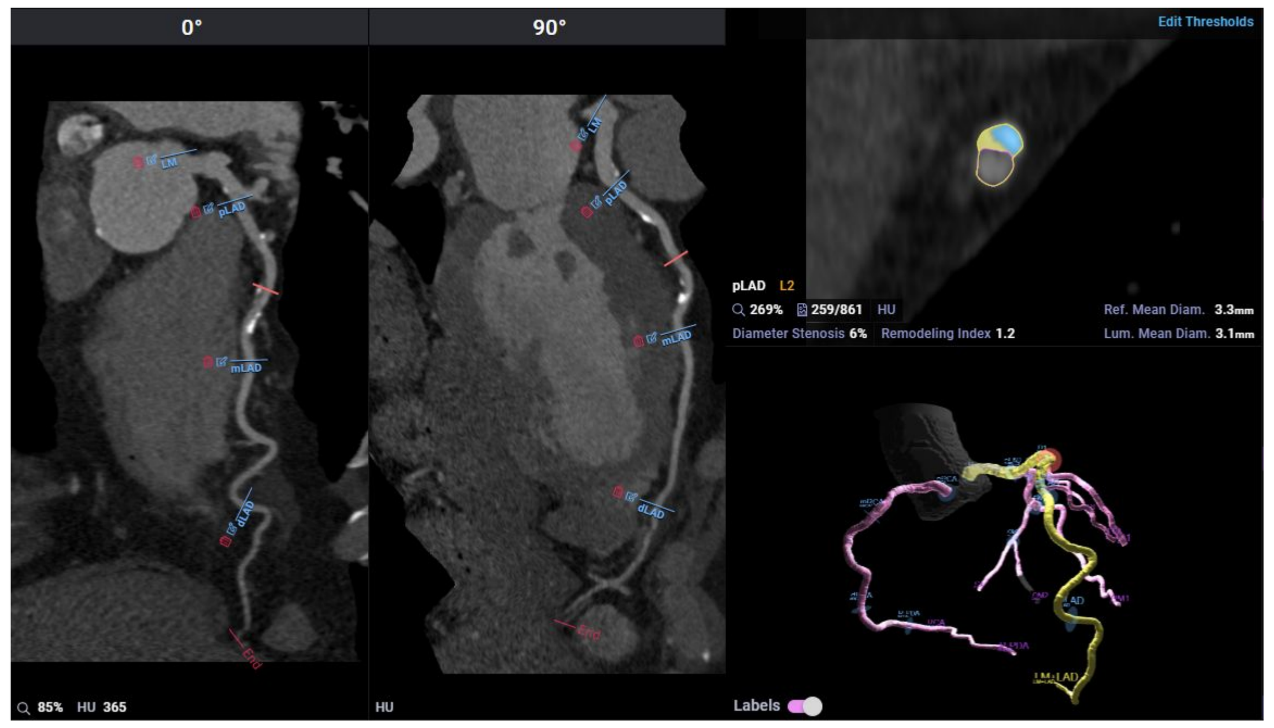
RESULTS

- AI-QCT median plaque volume was 95 mm^3 ± 238 mm^3.
- AI-QCT had a high agreement of 93% (k=0.87, 95% CI: 0.79-0.959) with SIS categories.
- AI-QCT detected low-volume plaque (11-250mm^3) that was not detected by visual SIS assessment.
- Agreement between AI-QCT and categories of visual assessment (64%; k=0.51 [0.395-0.631]), CACS (66%, k=0.49 [0.363-0.614]), and CAD-RADS (59%, k=0.45 [0.32-0.576]) was modest.

FIGURE 2

Non-Calcified Plaque detected by AI-QCT and missed by visual assessment
Case example of a right coronary artery with predominantly non-calcified plaque missed by visual assessment but detected by AI-QCT with plaque volume of 80 mm^3. The resulting CAD-RADS 2.0 category would change from CAD-RADS 0 to CAD-RADS 1 with a P1 moniker (1 vessel with mild amount of plaque).

FIGURE 3



AI-QCT example of non-obstructive CAD that is concordant with SIS.
Case example of a left anterior descending coronary artery in which plaque assessment by SIS and visual assessment was concordant with AI-QCT. The SIS is 4 with moderate calcified and non-calcified plaque burden involving the LAD on visual assessment. AI-QCT was concordant with a total plaque burden of 567 mm^3 which resulted in moderate (250-750 mm^3) category.

DISCLOSURES

JPE – employee and equity in Cleerly, Inc. TC – employee of Cleerly, Inc. ADC reports grant funding from GW Heart and Vascular Institute and equity in Cleerly, Inc. Consultant – Siemens. All other authors report no relevant disclosures.