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WHAT'S ROLE OF LATE IODINE ENHANCEMENT CARDIAC COMPUTED TOMOGRAPHY IN THE CARDIOPATHIC PATIENT?

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Introduction

In the clinical practice the cardiac magnetic resonance (CMR) with late gadolinium enhancement (LGE) represents the gold standard for myocardial characterization: especially in the assessment of coronary artery disease (CAD), establishing a diagnosis of acute or chronic myocardial infarction (MI) and above all allowing a differential diagnosis with non-ischemic causes of myocardial damage (such as myocarditis, cardiomyopathies, etc.) [1].

In patients with severe contraindications to CMR, or with hemodynamic instability, the use of cardiac computed tomography angiography (CCTA) with the evaluation of iodine delayed-enhancement, or late iodine enhancement (CT-LIE), represents an alternative method to identify myocardial scars and allowing a tissue characterization, as some studies have already shown [2,3,4].

Here we reported a clinical case report in which CT-LIE has been demonstrated an effective alternative to perform myocardial characterization especially in complicated patients with hemodynamic instability.

Case Report

A 54 yo man with ischemic symptoms and signs presentation (angor, elevated troponin levels, ECG alterations) and acute heart failure (reduced ejection fraction, EF) was hospitalized at Cardiology Department of Tor Vergata Hospital in Rome in May 2020. At coronary angiography no significative CAD was demonstrated at main coronary vessels, with the evidence of moderate-severe stenosis at left marginal arteries.

A CMR study was indicated for the patient, in particular for the assessment of ventricular function and myocardial characterization, but the hemodynamic instability represent a severe contraindication for the exam.

So a multidisciplinary team (made by cardiologists and radiologists) had placed the indication for CCTA, for a new evaluation of the coronary anatomy and furthermore to exclude a possible cardiomyopathy through the assessment of Delayed Enhancement.

CT was acquired on a 256-slice single-energy scanner (Revolution CT; GE Healthcare, Chicago, Illinois, Stati Uniti), and a retrospective ECG-gating was used according to heart rate of the patient.

A biphasic bolus injection of iodinated contrast agent (Iomeron 400 mgI/ml; Bracco, Milan, Italy) was administered for the angiographic phase. The injection scheme consisted of 60 ml Iomeron followed by 40 ml of saline flush, at a flow rate of 5 ml/sec. Unfortunately, the coronary evaluation was not possible because elevated heart rate of the patient.

A second bolus of iodinated contrast agent (70 ml at a flow rate of 5 ml/sec) was subsequently administrated for the evaluation of Delayed Enhancement, and a new scan was acquired after 7 minutes for the search of LIE. CT demonstrated a significative transmural LIE (i.e. hyperdensity area) in the lateral mid-basal wall, according to angiographic finding (moderate-severe stenosis at left marginal arteries.). So the iconographic features of the CT-LIE, together to the clinical presentation, led to the diagnosis of a severe myocardial damage in ischemic etiology. The apex and the anterior

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papillary muscle were also involved by Delayed Enhancement, in a clinical presentation of acute heart failure.
Moreover a multiphase reconstruction "earliest to latest -all" was performed, indicated for the cardiac functionality evaluation, that confirmed EF reduction, because the myocardial perfusion defect.

Discussion

CMR with the use of LGE represents the gold standard for the non-invasive assessment of myocardial characterization, especially it was demonstrated his diagnostic and prognostic role to define the pattern of ventricular wall involvement by myocardial scars [5]. Anyway, the magnetic resonance imaging exams present many contraindications and disadvantages, such as claustrophobia, low patient compliance, metallic devices (arthro-proteses, PMK, ICD, etc.) and high time duration.
The progressive improvement in CT technology, especially increased spatial and temporal resolution, has led to continuous expansion of its clinical application. In fact, thanks to a significant noise reduction for images acquired at low energy, it was possible to expand the application of CCTA to myocardial scar characterization.
In the same way as gadolinium, iodinated contrast agent accumulates into myocardial scar during the delayed phase (or equilibrium phase), and a low-energy CT manages to difference iodine concentration between scarred and non-scarred myocardium [6,7].
Besides, comparing it with the classic imaging methods for the evaluation of myocardial perfusion, those are the positron emission tomography (PET) or single-photon emission computed tomography (SPECT), the CT involves a net reduction in exposure to ionizing radiation, especially with the use of dual-energy CT (DECT).
It significantly reduces the flow of examinations required for the Patient through a complete one-step anatomical-functional diagnosis.

Conclusions

All of this places the CCTA as an alternative method to the CMR to establish a correct characterization of the myocardial tissue, faster and less contraindicated, also evaluating a possible etiology of myocardial damage based on the characteristics presented by the Delayed Enhancement.
Combining functional and anatomical evaluation using the CT would be ideal, since it offers the possibility of complete CAD evaluation using one modality, especially in complicated patients with many and severe contraindications to CMR [8].

References

1. Prabhakar R, Milind YD, Deborah K, Scott DF. MR imaging of myocardial infarction. Radiographics 2013;33(5):1383-412.
2. Wichmann JL, Arbaciauskaite R, Kerl JM, et al. Evaluation of monoenergetic late iodine enhancement dual-energy computed tomography for imaging of chronic myocardial infarction. European Radiology 2014;24:1211-18.
3. Matsuda T, Kido T, Itoh T, et al. Diagnostic accuracy of late iodine enhancement on cardiac computed tomography with a denoise filetr for the evaluation of myocardial infarction. Int J Cardiovasc Imaging 2015;31 Suppl 2:177-85.
4. Palmisano A, Vigbale D, Benedetti G, et al. Late iodine enhancement cardiac computed tomography for detection of myocardial scars: impact of experience in the clinical practice. La radiologia medica 2019;125(2):128-136.
5. Cummings KW, Bhalla S, Javidan-Nejad C, et al. A pattern-based approach to assessment of delayed enhancement in non-ischemic cardiomiopathy at MR imaging. Radiographics 2009;29(1):89-103.
6. Gerber BL, Belge B, Legros Gj, et al. Characterization of acute and chronic myocardial infarcts by multidetector computed tomography: comparison with contrast-enhanced magnetic resonance. Circulation 2006;113(6):823-833.
7. Wichmann JL, Bauer RW, Doss M, et al. Diagnostic accuracy of late iodine enhancement dual-energy computed tomography for the detection of chronic myocardial infarction compared with late gadolinium enhancement 3-T magnetic resonance imaging. Investigative radiology 2013;48(12).

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

8. Van Assen M, Vonder M, Pelgrim GJ, et al. Computed tomography for myocardial characterization in ischemic heart disease: a state-of-art review. European Radiology Experimental 2020;4:36.

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Figures Legend

Fig. 1a: Four-chambers cardiac view – angiographic phase
Fig. 1b: Four-chambers cardiac view – delayed enhancement
Fig. 2a: Short-axis mid-basal cardiac view – angiographic phase
Fig. 2b: Short-axis mid-basal cardiac view – delayed enhancement
Fig. 3a: CCTA mid-basal lateral wall thickness
Fig. 3b: Late iodine enhancement (LIE) mid-basal lateral wall thickness
Fig. 4: Multiphase reconstruction "earliest to latest -all" for cardiac functionality evaluation (EF included)

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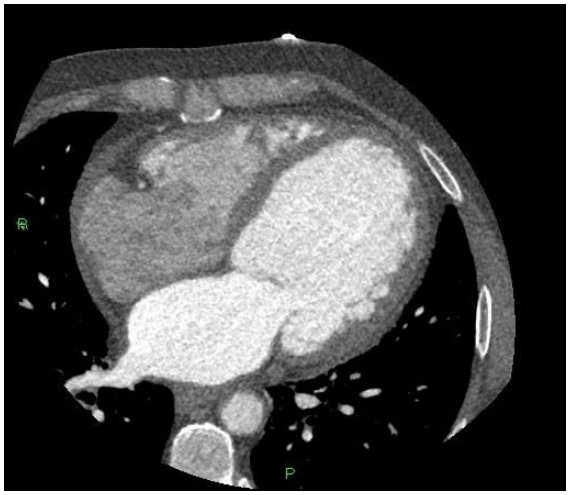

Fig. 1a: Four-chambers cardiac view – angiographic phase

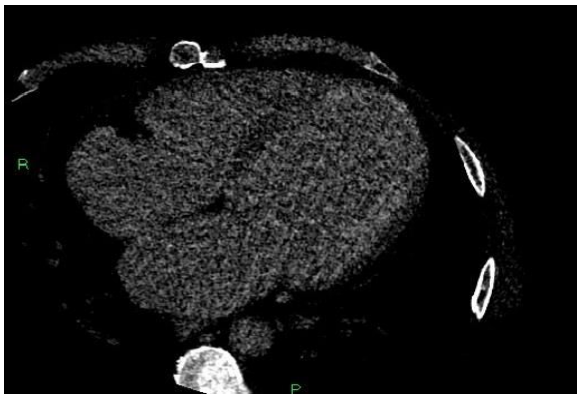

Fig. 1b: Four-chambers cardiac view – delayed enhancement

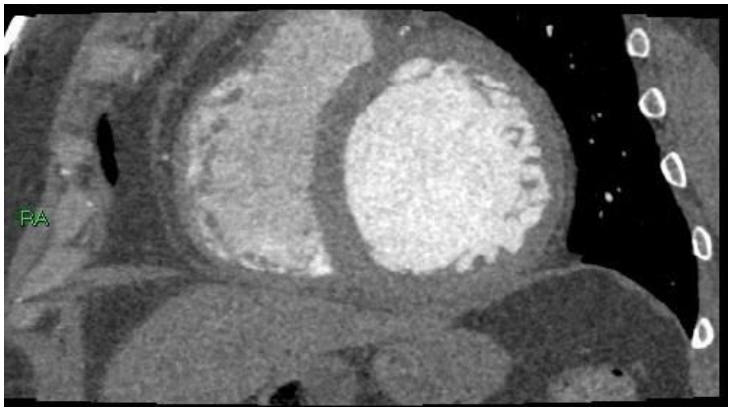

Fig. 2a: Short-axis mid-basal cardiac view – angiographic phase

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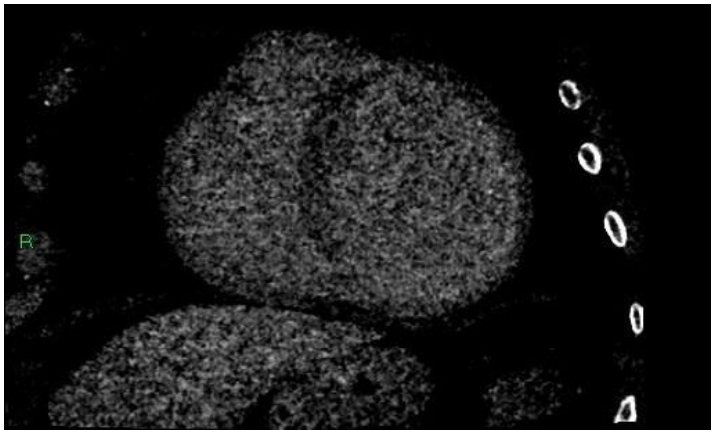

Fig. 2b: Short-axis mid-basal cardiac view – delayed enhancement

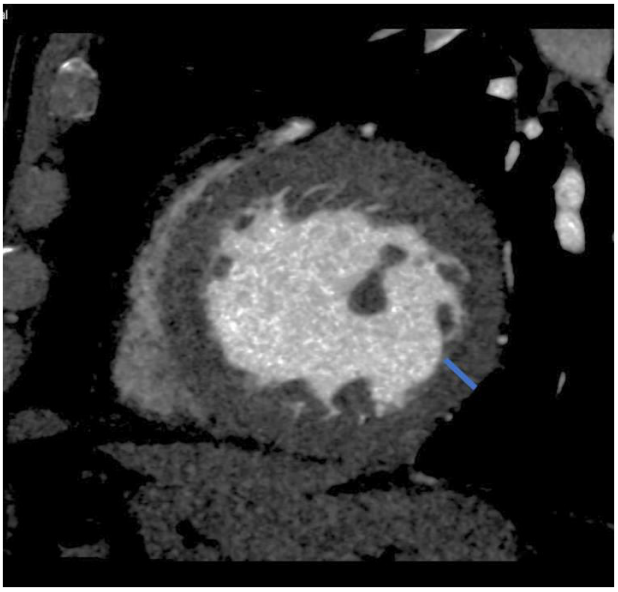

Fig. 3a: CCTA mid-basal lateral wall thickness

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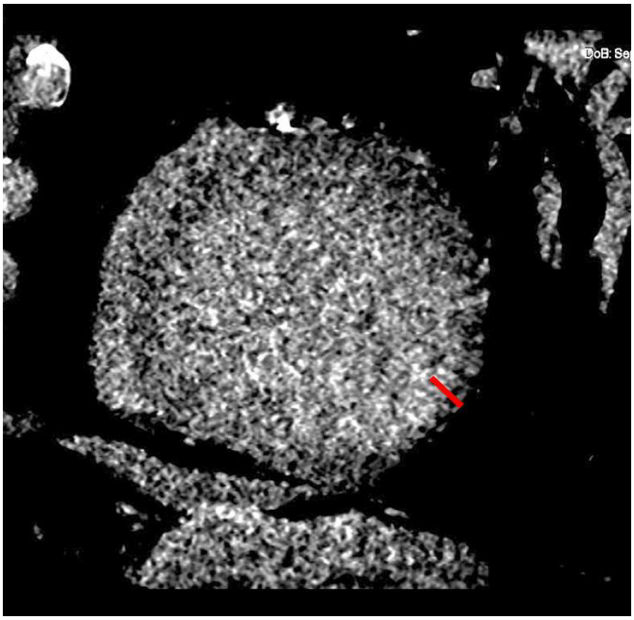

Fig. 3b: Late iodine enhancement (LIE) mid-basal lateral wall thickness

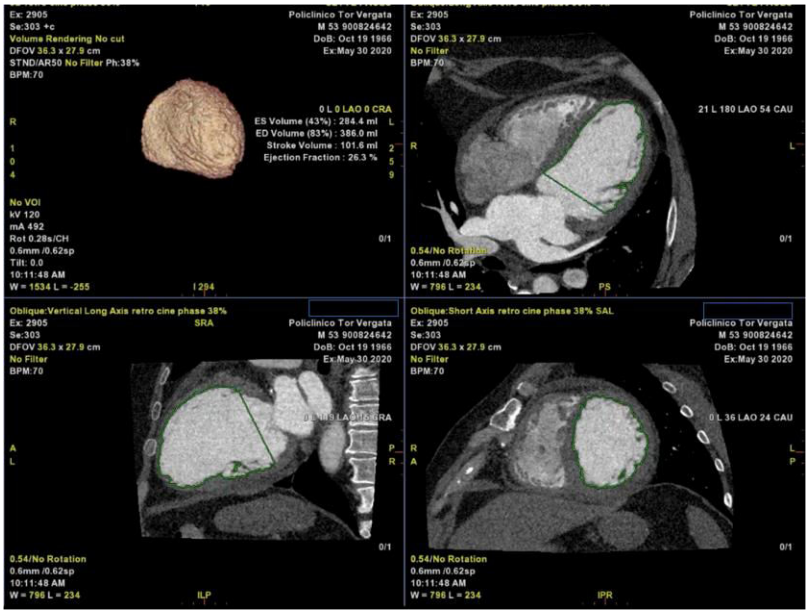

Fig. 4: Multiphase reconstruction "earliest to latest -all" for cardiac functionality evaluation (EF included)