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EDITORIAL

Contrast echocardiography: What's new?

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ABSTRACT

Over the last two decades, regardless of advances in cardiac imaging technologies, echocardiography has sustained its leading role as a diagnostic tool in cardiovascular medicine. The foremost reason is because of its unique advantages comprising versatility, portability, rapid availability even at the bed side, excellent temporal resolution, elucidation of images in real time, comparatively low cost and above all no risk of exposure to radiation. In multiple clinical situations 2Dimensional echocardiography (2DE) is operated for imaging in OPD clinics, indoor wards, intensive care units, operation theatres and faraway locations.

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Introduction

It is well known that virtually 15-30% of non-contrast echocardiographic studies are substandard, inadequate and unacceptable [1]. Notably, in the current era there has been an exponential increment in the applications of contrast echocardiography with the emergence of newest second-generation ultrasound contrast agents (USCAs) [2]. It is noteworthy that because of relentless investigations and research in the area of contrast echo, several innovative and state-of-the-art techniques are evolving for the wider implementation of this outstanding invention. A comprehensive recommendation has been proposed by the American Society of Echocardiography regarding the usage of this highly skillful technique and even the responsibilities of healthcare contributors has been outlined [2].

Contemporary clinical applications of left ventricular (LV) and vascular opacification for augmentation of contrast images in myriads of cardiovascular diseases are enumerated below:

1. Endocardial border definition of LV (Figure 1A)
2. Estimation of LV ejection
3. fraction (LVEF), dimensions and volumes (Figure 1B).
4. Enhancement of doppler recordings (Figure 1C).
5. Amplification of regional wall motion abnormalities at rest (Figure 1D).
6. Amplification of regional wall motion abnormalities during stress (Figure 1E).
7. Delineation of Apical hypertrophic cardiomyopathy (Figure 1F), Non compaction cardiomyopathy (Figure 1G), LV thrombus (Figure 1H), Eosinophilic cardiomyopathy (Figure 1I) and LV pseudoaneurysm (Figure 1J).
8. Discernment and characterisation of non-thrombotic masses (Figure 1K).
9. Unmasking of aortic dissection (Figure 1L).
10. Myocardial contrast echocardiography (Figure 1M).
11. Myocardial perfusion imaging (Figure1N).

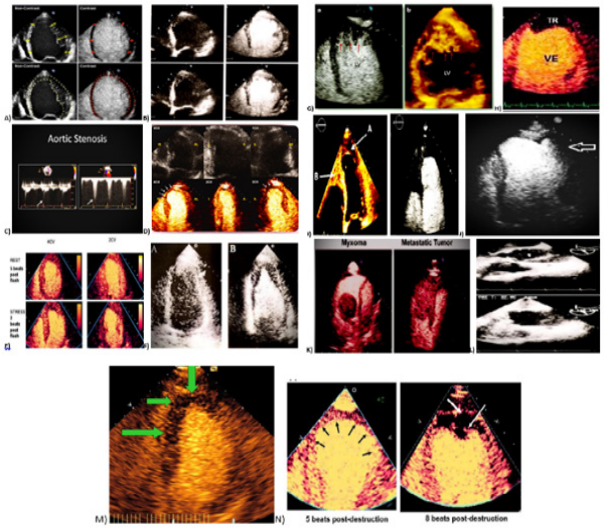

Figure 1. A) LV border definition. Left panel unenhanced image, Right panel enhanced image in a patient of dilated cardiomyopathy. B) Estimation of LV volumes and ejection fraction. C), Continuous wave doppler image enhancement of a patient with severe Aortic stenosis. D), Identification of segmental wall motion analysis at rest, by Transthoracic myocardial contrast Echocardiography. E), Identification of LV segmentation wall motion analysis after stress, consistent with multi-vessel coronary artery disease. F), Detection of Apical Hypertrophic Cardiomyopathy. G) Detection of Non-Compaction Cardiomyopathy. Left panel showing deep recesses (red arrows), Right panel is 3D reconstruction of the same image. H), Deleniation of LV apical thrombus. I), Detection of Eosinophilic Cardiomyopathy. J), Depiction of LV pseudoaneurysm. K), Detection of LV non- thrombotic masses- myxoma and metastatic tumor. L), Depiction of Aortic dissection flap, true and false lumen. M), Myocardial contrast echocardiography. N), Myocardial contrast perfusion Echocardiography in a patient of apical myocardial infarction.

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Keeping pace with the advancement of technology and artificial intelligence (AI) newer, innovative and ultra-sophisticated applications of USCAs are underway both for diagnosis and therapy of cardiovascular pathologies [3, 4]. Several ingenious, futuristic and pioneering endeavors which are on the horizon are mentioned:

Molecular imaging

Non-invasive molecular imaging (MI) can yield extremely precise diagnosis. MI employing contrast enhanced ultrasound (CEU) is a scientific maneuver that relies on ultrasound (US) identification of microbubble contrast agents to target the molecular or cellular phenomenon that originate at the interface of blood pool and endothelium. A distinctive knowledge is accomplished on ischemia (Figure 2A), atherosclerosis, angiogenesis, reperfusion injury, thrombus formation, vascular injury and swelling. Correspondingly, MI guides the appropriate therapy based on vascular phenotype.

Contrast-enhanced ultrasound imaging of intraplaque neovascularization

Neovascularisation assessed by CEU imaging is associated with plaque echolucency, a well-accepted marker of high-risk lesions, and does not depend on the degree of stenosis. CEU imaging may identify highly vascularised potentially vulnerable plaques, and furthermore, may therefore be a new tool for plaque risk stratification, beyond the simple evaluation of stenosis and echogenicity, and for the assessment of progression and regression of atherosclerosis. Till date the research has been directed towards the carotid artery plaques (Figure 2B), nonetheless, in future, CEU imaging may be a novel technique for detection of vulnerable plaques in the coronary arteries causing acute coronary syndrome.

Therapeutic contrast echocardiography

It has been recently reported that transthoracic high mechanical index (MI) impulses from a diagnostic ultrasound transducer (DUS), during an intravenous microbubble infusion (sonothrombolysis) can restore epicardial and microvascular flow in acute ST-segment elevation myocardial infarction (STEMI) (Figure 2C, 2D), The effect of sonothrombolysis were recognised early in the treatment period before emergent PCI, but resulted in sustained improvements in systolic function and reduced the need for defibrillators at 6-month follow up.

Intracavitary blood flow patterns

- Vortex formation (Figure 2E)
- Energy dissipation
- Resonance time to LV diastolic filling is being investigated in normal and pathological states

Bio effects of ultrasound

Nowadays microbubble cavitation, convective motion and microstreaming have been employed to evoke increased permeability of vessels for extravascular expatriation of medications and genes (Figure 2F). This will result in simultaneous concentration of shear related bioeffects through USCAs. Correspondingly, it would augment tissue perfusion in coronary artery disease and ultimately reduce the infarct size, in patients of STEMI undergoing primary PCI.

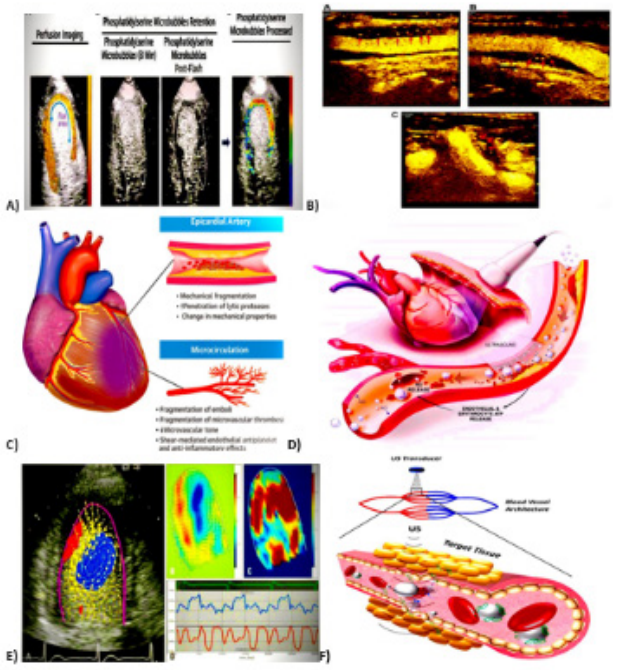

Figure 1. A), Molecular imaging in patients with Acute Coronary Syndrome. B), Contrast intraplaque neovascularization depicted by contrast enhanced ultrasound. C), Schematic illustration for myocardial infarct size reduction by contrast enhanced ultrasound. Microbubble cavitation effects on epicardial arteries and microcirculation. D), Sonothrombolysis for STEMI and restoration of epicardial and microvascular circulation. E), LV vortex flow (a), analysed by contrast echocardiography using particle image velocimetry method, (b), Parametric representations of steady streaming field, c), pulsatile strength field, (d), and vortex size change throughout the cardiac cycle. F), Schematic representation of how microbubble cavitation facilitates DNA (green) extravasation into tissue.

Summary

Standard 2Dimensional echocardiography maybe often suboptimal falsely negative or inconclusive, even though it is currently considered an indispensable tool for a contemporary non-invasive cardiovascular facility. It is specifically meant to generate exceptional information which increases the diagnostic presentation and moreover provides credence to the reader, in particular. Contrast echocardiography necessitates knowledge of the recent protocols and the robust echocardiography workroom policies that determine the quality, efficiency and safely of the procedure.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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