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*RESEARCH ARTICLE*

# CLINICAL SUSPICION OF LEFT VENTRICULAR APICAL THROMBUS - WHAT TO DO?: A CASE REPORT

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## *Abstract*

Thrombi represent the most frequently found intracardiac masses. Left ventricular thrombus (LVT) is an important complication in patients with ischemic heart diseases and in those with dilated cardiomyopathy and systolic heart failure. The diagnosis of left ventricular thrombus remains important since anticoagulation will reduce the risk of systemic embolization and stroke. Despite advances in other imaging modalities, echocardiography remains the most important tool for diagnosis and risk stratification in patients predisposed to develop left ventricular thrombi. We are presenting a case report of 62 years old gentleman who had suffered from anterior wall myocardial infarction (AWMI) in the recent past, and now has developed LVT which was detected by contrast tuned imaging (CTI) based contrast echocardiography. This is a first case report of detection of LVT by this ingenious technology.



## Introduction:-

Typically, thrombus is categorized as an explicit echo image with a clear-cut edges. LVT conventionally are stationed in depressed contractile areas of left ventricle (LV) [1]. "Virchow's triad", the quintessential process for the LVT formation comprises of (i) prothrombotic state, (ii) endothelial injury and (iii) stagnation of blood flow. A depressed velocity of swirling motion of blood stimulates the development of LVT which may dissolve on its own, embolize or proliferate (1).

It has been postulated that LVT provides a protection against LV rupture by extending a strong mechanical support to the underlying myocardium, thus limiting the remodelling and LV scar formation (Figure 1).

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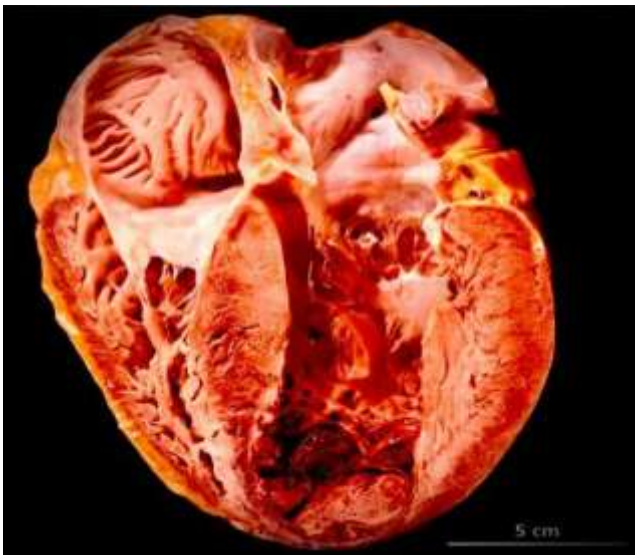
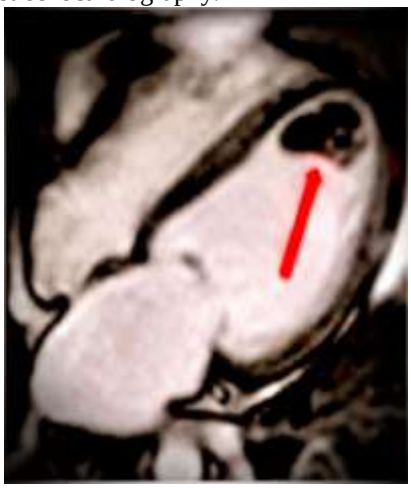
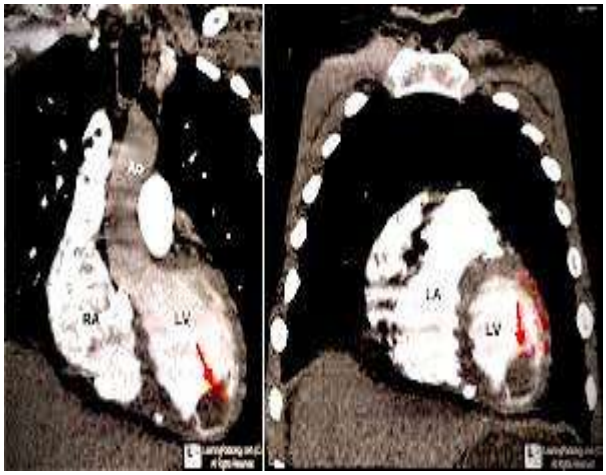



**Figure 1:-** Pathological specimen of LV apical thrombus. The thrombus is firmly attached to the apex and helps in enhancing the underlying myocardial scar alongwith restoring the thickness of the myocardial wall.

The incidence of LVT complicating an AWMI has been significantly reduced to 5 % - 15 % [2-4], post early revascularization and anticoagulation.

Currently, myriads of imaging modalities are at our disposal (Figure 2), to identify and illustrate the characteristics of LVT: cardiac magnetic resonance (CMR), cardiac computed tomography (CCT), left ventriculography, strain imaging utilising speckle tracking echocardiography, standard 2Dimensional transthoracic echocardiography (TTE) and contrast echocardiography.

a)  b) 

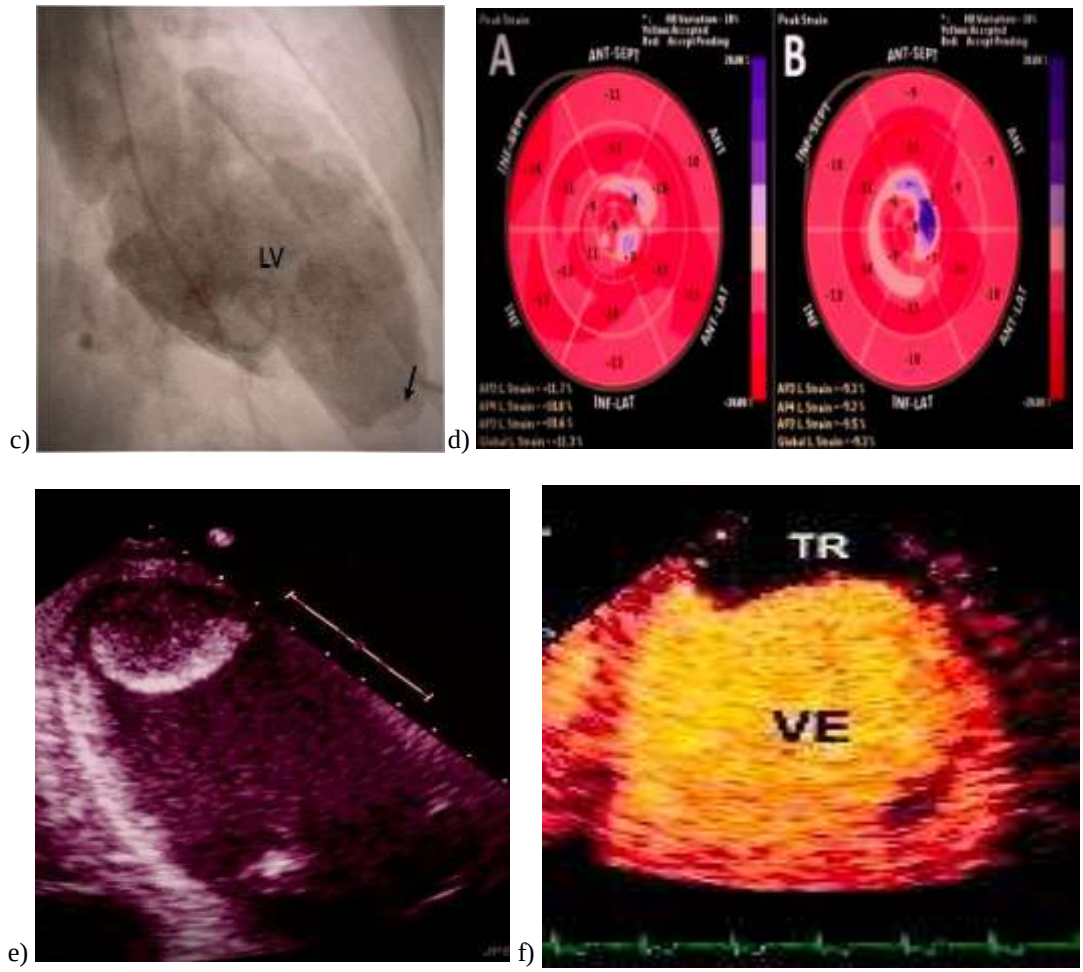



**Figure 2:-**

a) Cardiac Magnetic Resonance Imaging of LV apical thrombus.
b) Two reformatted gated CT images of the LV showing a filling defect (red arrow) in the apex, LA, left atrium, RA, right atrium.
c) Left ventriculography in right anterior oblique view demonstrating a filling defect within the left ventricular apex suggestive of an apical thrombus.
d) Strain imaging employing speckle tracking echocardiography. On the left panel (A) is "Bulls" eye mapping of strain imaging in a patient without LV apical thrombus, and on the right panel (B) is a patient of LV apical thrombus.
e) LV apical thrombus identified by standard 2D echocardiography.
f) Contrast echocardiography delineation of LV apical thrombus.

TTE remains the most versatile imaging technique to accomplish a diagnosis of LVT and has a sensitivity of 90-95 % and specificity of 85 - 95 % for detection of LVT [5, 6]. Asinger et al [7] enumerated the high risk echocardiographic features for development of LVT (Table 1).

**Table.1:-** High risk echocardiographic features for LVT [7].

| S. No. | High risk echocardiographic features for the development of LVT |
|---|---|
| 1 | Large infarct size |
| 2 | Anterior myocardial infarction |
| 3 | Severe LV systolic dysfunction |
| 4 | LV dilatation |
| 5 | Spontaneous echo contrast |
| 6 | Anomalous LV flow pattern |

| | |
|---|---|
| 7 | Swirling motion of LV apical flow |
| 8 | Vortex ring formation |

TTE can only detect around 10% of thrombi less than 1 cm in size, [8]. However it is noteworthy that suboptimal studies due to technically difficult visualization of endomyocardial borders [9], may limit the accurate assessment of segmental wall motion, ejection fraction (EF), and the presence or absence of left ventricular thrombus (LVT) [10, 11]. Contrast echocardiography has been shown to significantly improve the detection of a LVT (sensitivity and specificity are 61% and 99% respectively) ,augment the endocardial border elucidation and the image caliber [12]. Thus, contrast echocardiography is recommended when standard imaging proves inconclusive, which may be in as many as half of imaging studies [10]. Contrast echocardiography is an easy, cost-effective with a potential to enhance the detection of LVT in patients with MI [13].

**Contrast tuned imaging technology for left ventricular contrast echocardiography**

Contrast tuned imaging (CTI) is an advanced technology for contrast-enhanced ultrasound (CEUS) imaging. Based on low mechanical index and real-time scanning, CTI represents the best way to use second-generation contrast media [14].

CTI can be used for diagnosis and follow-up, as well as during interventional procedures. Its sophisticated architecture based on linear pulser technology, is capable of managing various typologies of pulsing techniques in order to optimize the beam forming management for a wide range of clinical applications.

Contrast-enhanced ultrasound has the advantages of the absence of ionizing radiation, widespread availability, even at the bedside, and the possibility to characterize a lesion as soon as it is detected on conventional 2-Dimensional echocardiography, commonly used as the first technique for exploration of the left ventricular opacification and other areas [15].

In CTI second generation contrast agents are utilized for left ventricular opacification. However, in the current case report we have employed CTI technology for left ventricular contrast echocardiography in the absence of intravenous contrast agent, to recognize and substantiate the presence of AHCM. To our knowledge, this is a first case report on CTI technology based contrast echocardiography for delineation of LVT.

**Case Report**

A 62 years old gentleman with a history of recent antero septal myocardial infarction (ASMI) diagnosed on resting ECG was referred to us for a comprehensive color doppler echocardiography. He denied the presence of any major cardiovascular risk factors. On clinical examination his pulse rate was 82/min, BP was 110/80 right upper limb in seated position, SPO2 was 98% at room air and respiratory rate was 16/min. On cardiovascular examination, the heart sounds were heard normally with the absence of clicks, murmurs or gallop sounds. Rest of the systemic examination was normal. Pathological investigations were unremarkable. High sensitivity troponin-T and lipid profile were within normal range. The resting ECG (Figure 3) identified the presence of pathological Q waves in leads $V_1$ - $V_3$ with T wave inversions in leads AVL and $V_1$ - $V_5$, consistent with sub-acute myocardial infarction. Xray chest PA view (Figure 4) was normal with absence of cardiomegaly or pulmonary venous congestion.

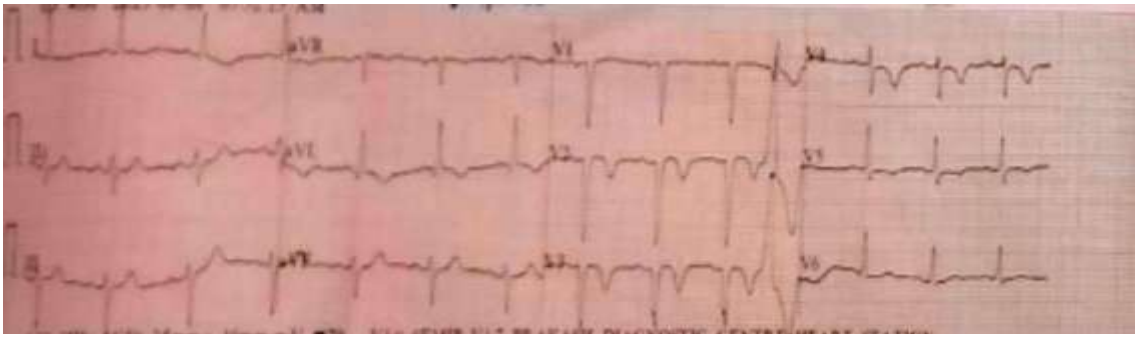


**Figure 3:-** Resting ECG recognizes the presence of pathological Q waves in leads V1- V3 with T wave inversions in AVL and V1- V5, consistent with subacute AWMI. Moreover, there is presence of Normal Sinus Rhythm with left axis deviation.

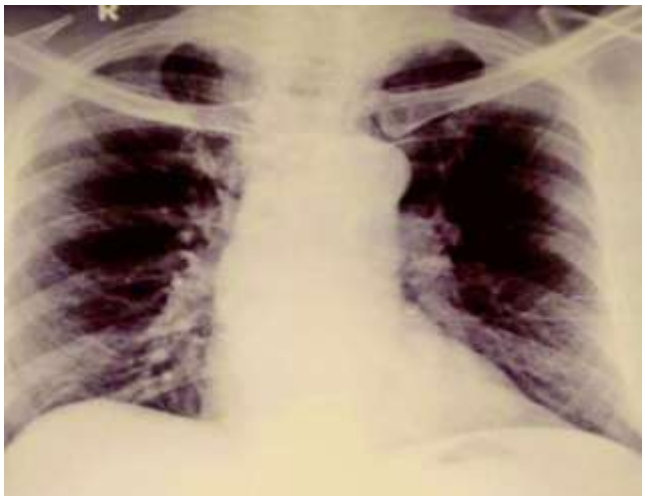


**Figure 4:-** X-ray Chest PA view appears to be normal. There is no cardiomegaly or pulmonary venous congestion.

**2Dimensional Transthoraic Echocardiography**

TTE was performed by the author in the left lateral decubitus position from the LX, SX, 4CH and 5CH views (Figure 5).

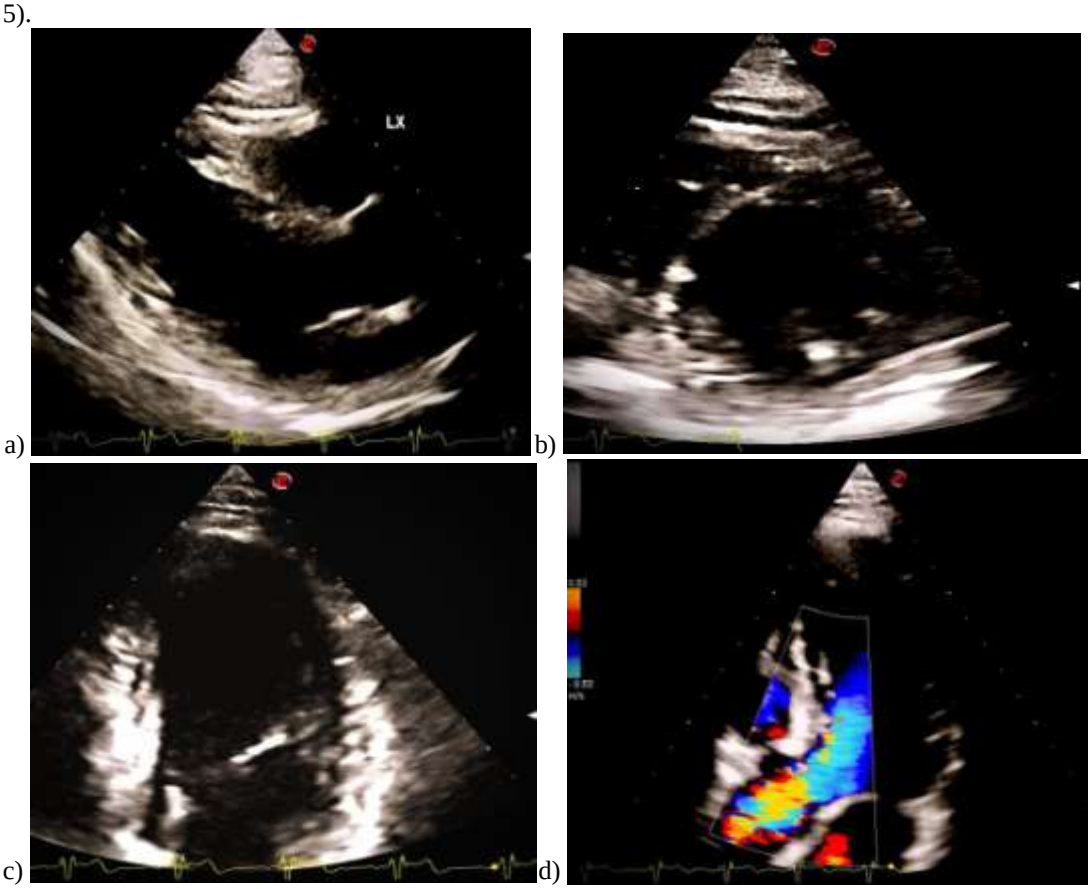



**Figure 5:-** Standard 2Dimensional -,Transthoracic Echocardiography was performed in ( a), LX View, (b), SX View,(c), 4CH View(c) and ( d)5CH View. There was presence of hypokinesia in anterior, mid septum, mid anterior septum, apical and mid anterior wall (LAD Territory).

Presence of hypokinesia was recognised in anterior, mid septum, mid anterior septum apical and mid anterior wall, suggestive of a ischemia in the left anterior descending artery territory. LV volumes and ejection fraction were

estimated by utilizing biplane Simpson's method (Figure 6) and were observed to be normal. There was an absence of any LV dilatation and the LVEF was normal (64%).

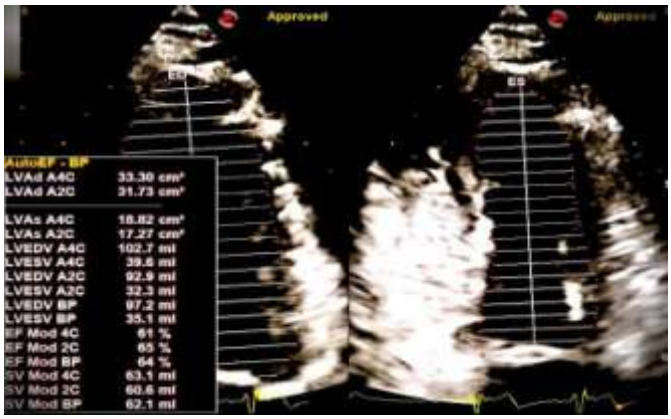



**Figure 6:-** Biplane Simpson's method was adopted for calculation of LV volumes and LVEF. There was absence of LV chamber dilatation with normal volumes and LV systolic function. LVEF was 64 %.

Pulse wave doppler (PWD) analysis (Figure 7) of mitral valve showed LV diastolic relaxation dysfunction (diastolic dysfunction grade 1) and moreover tissue doppler imaging (TDI) estimated the E/E` ratio to be 7: 1 which is within normal range.

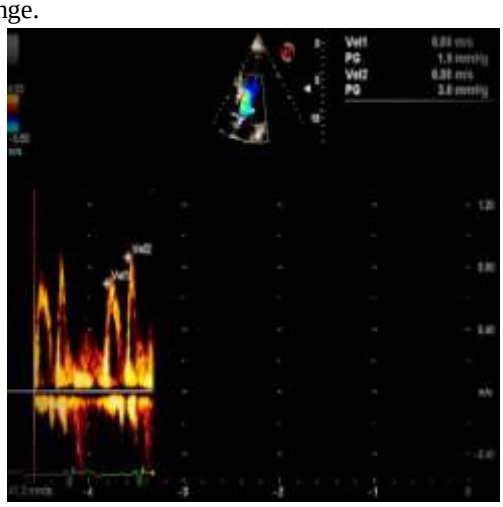
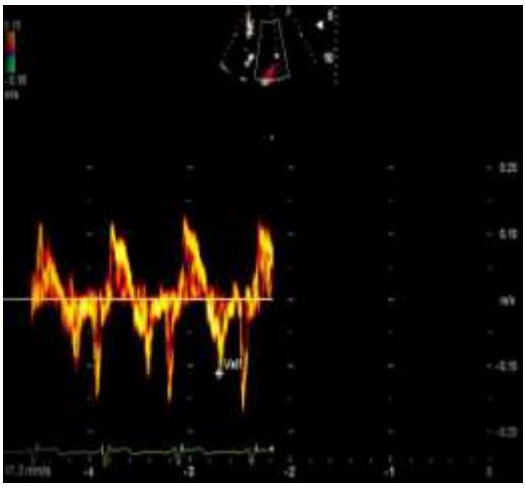
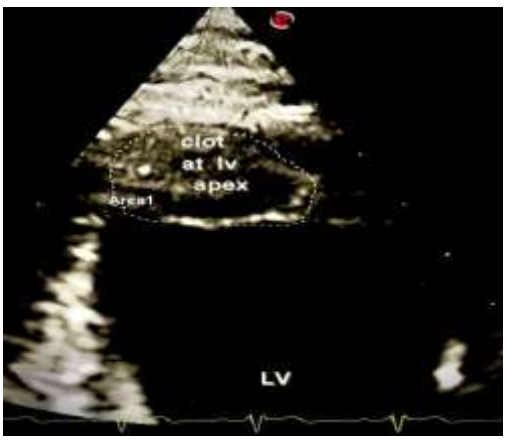
a)  b) 

**Figure 7:-** (a), On the left panel pulse wave doppler at the tip of mitral valve showed LV diastolic relaxation dysfunction (diastolic dysfunction grade 1), (b), On the right panel, tissue doppler Imaging of the LV estimated the E/E' ratio was 7:1 (within normal range).

Because of the presence of subacute ASMI, involving the LV apex, 4CH echocardiography in diastole and systole was zealously attempted to rule out the presence of LVT.

**Contrast Tuned imaging technology based LV Contrast Echocardiography**

A hazy and unclear image was discovered at the LV apex (Figure 8), after repeated attempts of focused imaging with 2Dimensional echocardiography.

a) 

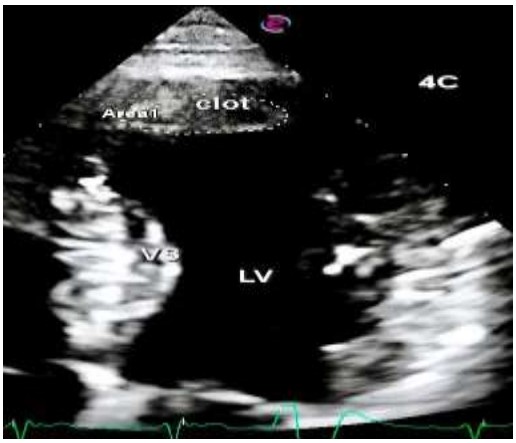
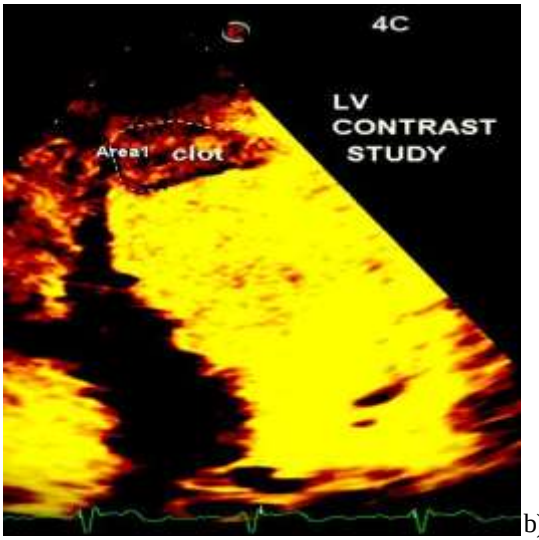
b) 


**Figure 8:-** Transthoracic Echocardiography in 4CH View, (a), on the left panel in diastole and (b), on the right panel in systole, reveals a hazy and unclear image of LV apical thrombus, highlighted by tracing the edges of the thrombus with dotted line.

Nonetheless on contrast tuned imaging (CTI) based LV contrast echocardiography the LVT was distinctly appreciated (Figure 9). The LVT was of moderate size (3.28 sq.cm), non pedunculated, mildly mobile and non-calcified. (We want to clearly state that no intravenous contrast agent was used during this procedure).

a) 

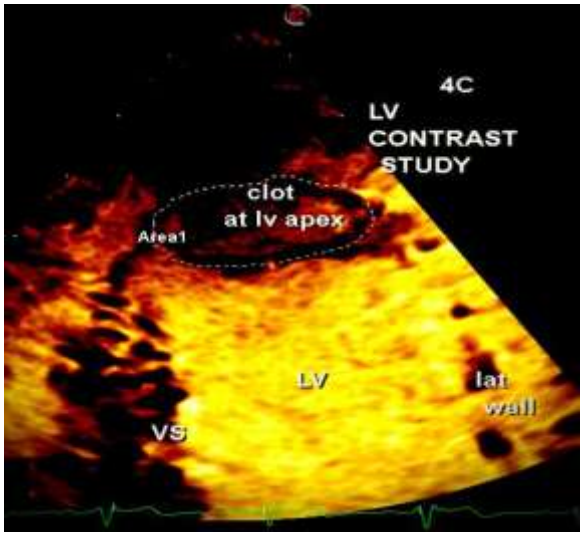
b) 


**Figure 9:-** Contrast Tuned Imaging Echocardiography distinctly portrayed the LV apical thrombus in (a), on the left panel in diastole and (b), on the right panel in systole.

**4Dimensional XStrain Speckle Tracking Echocardiography**

The striking features of 4Dimensional XStrain speckle tracking echocardiography are summarised below (Figure 10):

1. Cardiac output and sphericity index were normal. 4D LVEF was 51.99%.
2. "Bulls" eye mapping of LV strain - global LV strain, 2CH strain, LAX strain and 4CH strain were - 9.92%, - 8.88% - 8·12% and -12.75% respectively. The values are consistent with severe depression of strain in all the views.
3. Individual polar mapping of the strain values in different views similarly reflected a marked decline, particularly in the apical segments.
4. Furthermore, conspicuously, there was substantial decrease in LV strain values, ranging from - 0.54 to - 1.94 % in the apical segments.

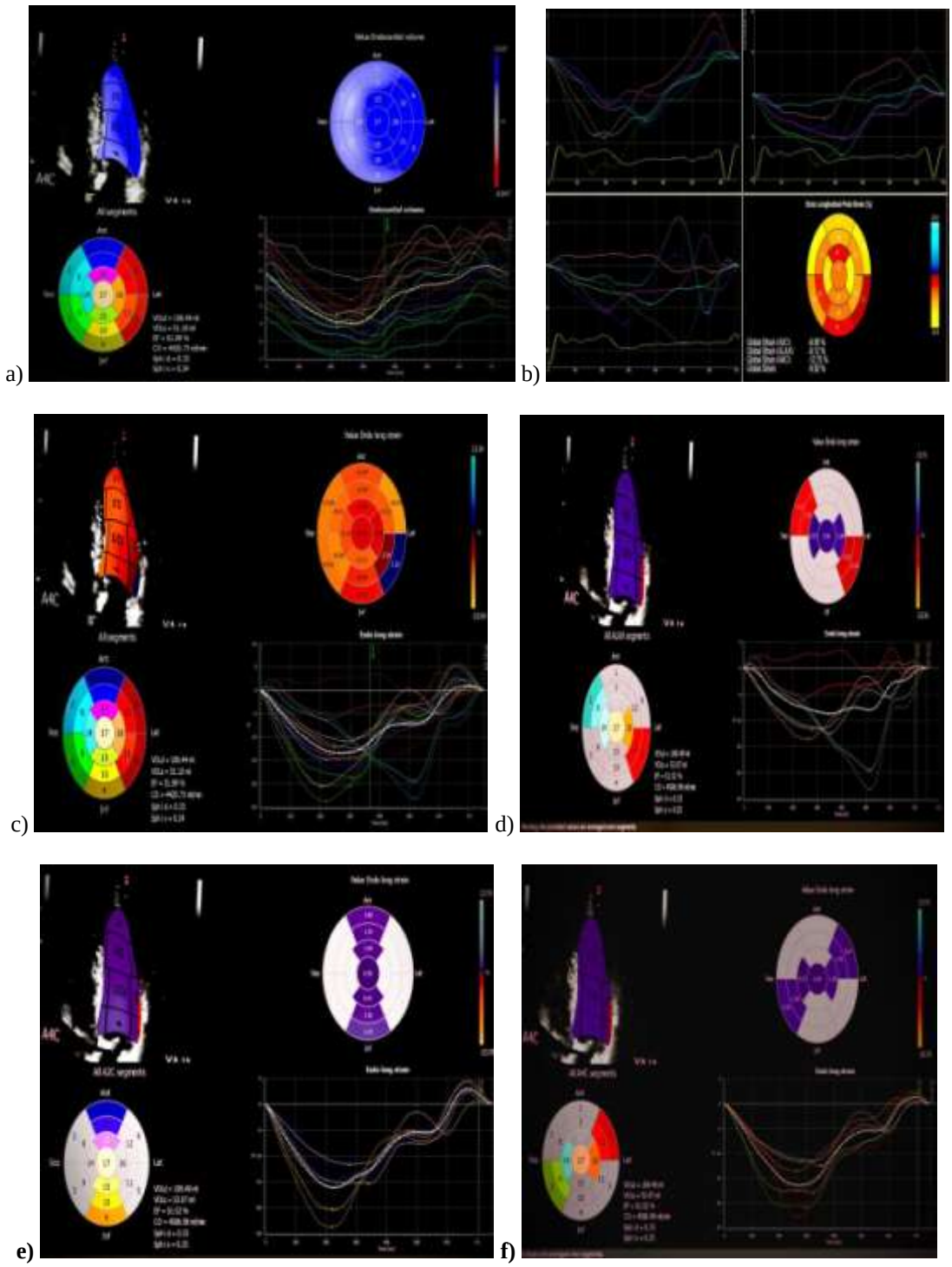


**Figure 10:-** 4Dimensional XStrain speckle tracking echocardiography-a) LV volumes, cardiac output, sphericity index and ejection fraction were normal- LVEF 51.99 %, b) "Bulls" eye representation of polar mapping of LV strain identified severely depressed values of LV strain - global LV strain, 2CH strain, LAX strain and 4CH strain were -9.92 %, -8.88 %, -8.12 % and -12.75 % respectively, c) polar mapping of strain of all the LV segments recognized marked depression of strain values in all the segments, particularly in the apical region , d- f) polar mapping of LV strain in LAX, 2 CH and 4CH view conspicuously revealed LV strain values ranging from - 0.54 to - 1.94 % in the apical segments.

## Discussion:-

A LVT appears as an echo-dense mass distinct from the LV wall, but adjacent to an area of abnormal wall motion [16]. Despite the widespread use of TTE, diagnostic performance is suboptimal with a sensitivity of only 33% and specificity of 91% [11]. TTE can be technically challenging as a result of an indistinguishable myocardial-thrombus interface, foreshortening of the LV apex or poor visualization of small protuberant thrombi or mural thrombi of any size [6].

To visualize the LVT at the apex, the preferred imaging planes are the apical views, since the transducer is adjacent to the LV apex. A thrombus has usually an echodensity similar to the myocardium while pannus appears more hyperechoic [17].

**Contrast tuned imaging echocardiography**

CTI is sophisticated technology for Contrast Enhanced Ultrasound (CEUS) imaging [18]. Based on low mechanical index and real-time scanning, CTI is an immaculate way to utilize second-generation contrast media. CTI is delineated by:

1. High Sensitivity - detection of the lowest intensity signals.
2. High Homogeneity same representation for signals - whether emanating from same vessels or same tissues.
3. High Spatial Resolution - recognition of very small structures (both hyperechoic and hypoechoic).
4. High Temporal Resolution - real-time detailed analysis of arterial and venous phase.

**Contrast Enhanced Ultrasound**

Ultrasound contrast agents are liquid suspensions of biocompatible gas-filled microspheres. When injected into a patient's vein, they circulate in the cardiovascular system, producing augmented ultrasound reflectivity. CEUS uses special biocompatible ultrasound contrast agents to improve the quality and reliability of ultrasound scans, thereby accurately diagnose medical conditions and monitor therapy. In our index patient the LVT was a hazy structure at the LV apex on 2Dimensional echocardiography. With utilization of CTI technology the LVT was strikingly delineated, despite non employment of intravenous contrast agents.

**Decorrelated Contrast Tuned Imaging**

An exceptional, CTI offers decorrelated contrast tuned imaging (DCTI) function [18], which spontaneously captures the breaking frame and decorrelates the signal, thus eradicating all artifacts by increasing sensitivity in the late phase. DCTI is designed to boost the contrast information. By using specific decorrelation software and combining the technique with a low and high mechanical index, DCTI is able to detect even the feeble information from low concentrations of contrast agent circulating even after five minutes of the bolus injection. DCTI technology is depicted by

1. High-Power transmission to destroy the microbubbles and saving the first frame after their demolition.
2. Maximising the diagnostic information by applying a decorrelation algorithm and integrating low and high mechanical index technologies.
3. Heightened ability to distinguish between a signal coming from static tissue and contrast agent bubbles inside the vessels.

**4Dimensional XStrain Speckle Tracking Echocardiography**

In a cross-sectional study of 211 participants of AWMI, with a primary percutaneous coronary intervention and a diminished LV systolic function (LVEF $\leq$ 40%), were investigated to assess the prognostic value of apical longitudinal strain (ALS) utilizing 2Dimensional echocardiography [19]. The aim of the study was to evaluate the ALS in subjects with LVT and in those without LVT. The salient features of their study exhibited that the apical strain (AS) and LVEF were notably lower in patients of LVT than those patients without LVT. Moreover, on applying the univariate and multivariate statistical analysis displayed that AS was an independent predictor of LVT. Interestingly, receiver operating characteristic (ROC) curve suggested a cutoff value of - 6.5% for AS, which predicted the development of LV apical thrombus with a sensitivity and specificity of 83% and 73% respectively. Furthermore, the study group reported that patients with a strain value of > - 6.5% had a 12.7 times. increase in thrombus risk. Correspondingly, in our patient there was a considerable decrease in the apical strain values (ranging from - 0.54% to - 1.94%).

AWMI in presence of apical dysfunction is a harbinger of escalated risk of LVT formation which may result in systemic embolization [20, 21]. Even though 2Dimensional echocardiography is contemporarily the cornerstone for

elucidating the LVT, nonetheless many a times it may not be adequate to recognise the hazy and unclear pictures of LVT [10,11]. Thus it is advocated that extremely focussed LV apical echocardiographic examination to be necessitated with a higher frequency transducer including a short focus for a highlighted near field resolution.

It is noteworthy that speckle tracking echocardiography has emerged as an established, objective and reproducible method to determine the LV strain for early detection of multiple cardiac entities, regardless of the echocardiac technique being employed [11 ,22, 23].

## Conclusions:-

The diagnosis and management of LV thrombus after AMI is a clinical conundrum despite significant progress in medical and device-based therapies. Early diagnosis of LV thrombus is critical to avoid thromboembolism, and the choice of imaging modality and timing in relation to the incident myocardial infarction are important. Standard echocardiography is often inconclusive or falsely negative regarding the detection of apical thrombus. There are many studies and guidelines support the use of contrast to improve diagnostic accuracy, especially in patients with suboptimal definition in routine echocardiography. Global longitudinal strain, particularly of the apical segments is an independent risk factor for LVT formation in the apical region after AWMI. An early accurate thrombus evaluation may prevent embolic complications, particularly cerebrovascular events. Assessment of ALS by 2Dimensional speckle tracking echocardiography is likely to become an a salient procedure in clinical practice. The role of newer oral anticoagulants (NOACs) remains poorly defined, and vitamin K antagonists (VKA) remains the mainstay of anticoagulation therapy until higher-quality evidence at least demonstrates noninferiority for the prevention of thromboembolic events. Strategies that target Virchow's triad by mitigating myocardial injury and preventing LV remodeling (stasis) and inflammation are likely to form the basis of the prevention and management of LV thrombus well into the future.

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