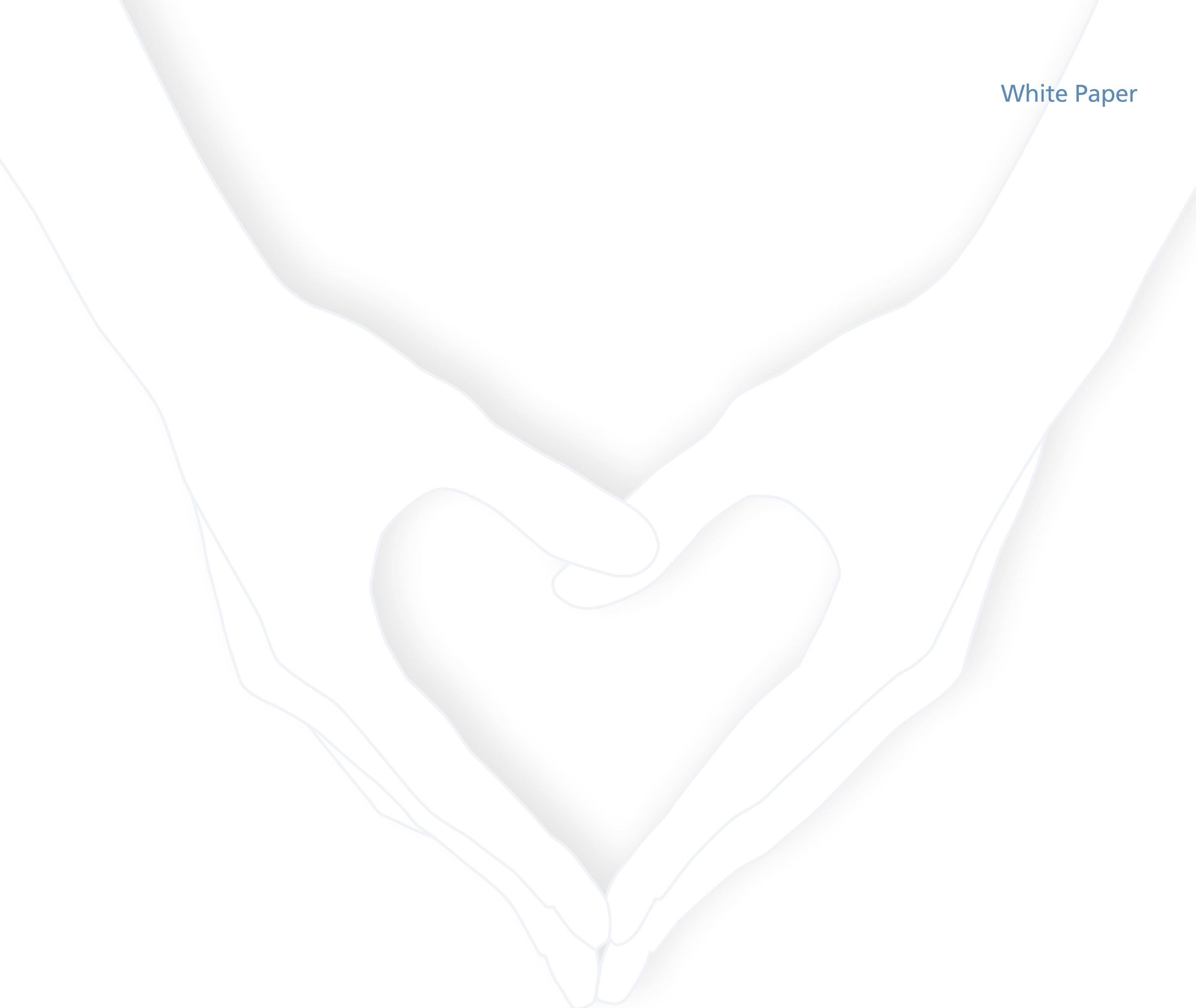
White Paper



Prevention Suite

esaote
Creativity in Healthcare

"Atherosclerosis is a systemic disease that remains asymptomatic for decades. With the integration of heart-vessel study (carotid IMT and stiffness with cardiac deformation index and coronary flow) we could draw a new roadmap to diagnose an early and personalized CVD risk assessment"

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In the global effort to reduce suffering and death from CVD, the World Heart and Stroke Forum (WHSF) Guideline Task Force of the World Heart Federation (WHF) recommends that every country should develop a policy on CVD prevention[1]

Therefore, the primary prevention of atherothrombosis diseases represents an increasing challenge worldwide[2]. So far, the atherosclerosis risk in asymptomatic patients has been weighed up by applying scores that take some risk factors into account and concern a general risk predisposition.

However, the risk for an individual within a population is not just a function of their absolute ranking in relation to others but of the overall risk of the population in which they live. An individual's risk should always be judged in the context of the CVD risk of the population as a whole[2,3].

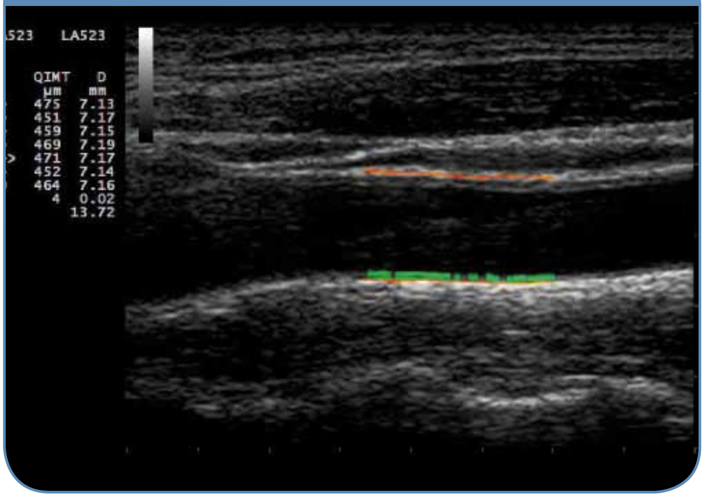
A large number of tools for estimating risk of CHD or other atherosclerotic disease have been developed over the past decades, including risk score charts, risk assessment algorithms, and computer software programs, but these could fail to identify the single subject with a real vascular risk for developing an ischemic disease[4,5].

Whatever technology we apply to detect asymptomatic subjects, we should strive for further refinements in risk prediction to identify intervention procedures[6].

However, before screening technology is used in routine clinical practice, the following screening criteria should be met[1,3]: the noninvasive tool for detecting CHD or other atherosclerotic disease is valid, precise, easy, and acceptable. Furthermore, this kind of technical screening should be employed by trained and expert operators, without biologically adverse effects and with an affordable cost, appropriate for the healthcare system, and justified by the outcome[3].

Although imaging approaches hold great appeal, they may remain too expensive and/or entail too high a radiation exposure to prove cost-effective or cost-beneficial for screening of unselected populations of unknown cardiovascular risk[6]. Endothelial-dependent vasodilatation assessed by a variety of techniques correlates with many risk factors, but not with complete fidelity[7]. Imaging approaches, both anatomical and functional, have generated great interest for cardiovascular risk prediction.

RF-Based Measurement of Carotid IMT (QIMT)



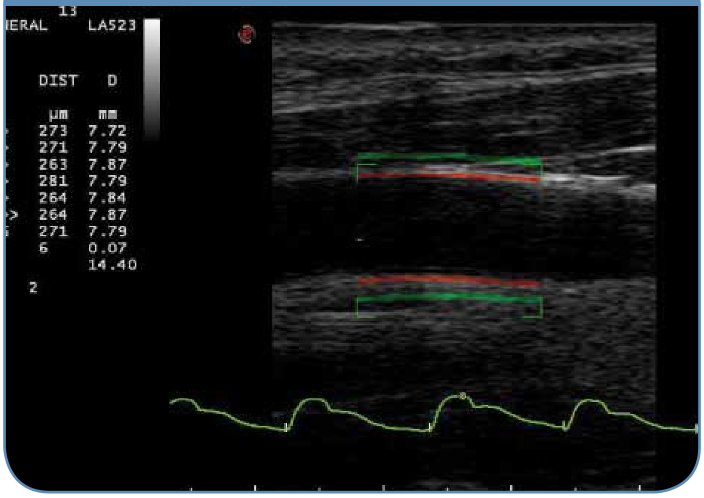
An optimal alignment of ultrasound probe across the longitudinal section of carotid artery is mandatory for accurate IMT measurement. With RF-based Esaote system, adequately depicted segments of IMT are indicated in green, the average IMT thickness is displayed beat-to-beat on the screen, and the mean value (MED) and standard deviation (SD) are continuously calculated. These inherent quality feedbacks allow achieving a correct probe position, optimal and stable IMT delineation and thus the correct and repeatable measurements.

Carotid IMT and stiffness

Carotid IMT has been shown to correlate with the degree of carotid atherosclerosis measured by autopsy[8] that, in turn, has been found to correlate with atherosclerotic burden in other arterial beds[9-10]. Consequently, carotid IMT is considered a surrogate marker of subclinical atherosclerosis. Increased carotid IMT is associated with CV risk factors[11-12], prevalent CV diseases[13] and coronary artery atherosclerosis[14-15].

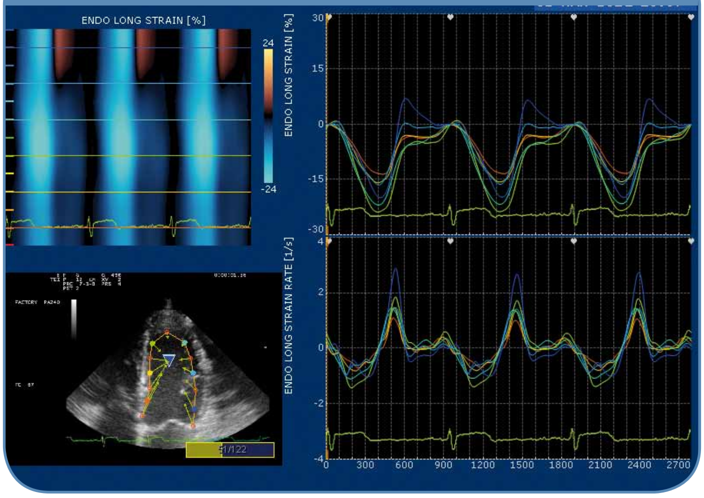
In the last years, a growing interest has been focused on arterial stiffening that reflects a loss of elasticity of the arterial wall, either due to atherosclerosis or arterial ageing. Increase in aortic stiffness, estimated by measuring carotid-femoral pulse wave velocity (PWV), has been shown to be associated with CV risk factors[16-17], with the presence and extent of atherosclerotic load in

RF-Based Measurement of Carotid Distensibility (QAS)



Continuous red lines indicates an adequate detection of carotid adventitia. Continuous green lines display dynamically the amplified vessel wall movement. Real.time distension waveform is displayed at the bottom (yellow line). The average carotid distention and diameter are displayed beat-to-beat on the screen, and the mean value (MED) and standard deviation (SD) are continuously calculated. From distention waveform, standard indices of carotid stiffness are automatically calculated.

2D STE - LV Function Strain and Strain Rate measurement



the coronary arteries[18] and with cardiovascular events in different populations[19-20].

Emerging evidence from cohort studies affirms that a calcium score derived from electron beam computed tomography may also add information regarding cardiovascular risk to traditional algorithms[21,22].

Cardiac deformation index

2D STE, resolving the multidimensional components of LV deformation, is another very promising imaging approach, that can play an important and incremental role in cardiovascular prevention field as the study of myocardial contractility function provides useful and predictive values against traditional LV Global Function assessment (Global EF) for determining subclinical cases that are likely to progress into Heart Failure. A growing body of evidence are reporting the presence of marked impairment of cardiac longitudinal and circumferential mechanics are reported in presence of preserved/minimal impaired Global LV function[23].

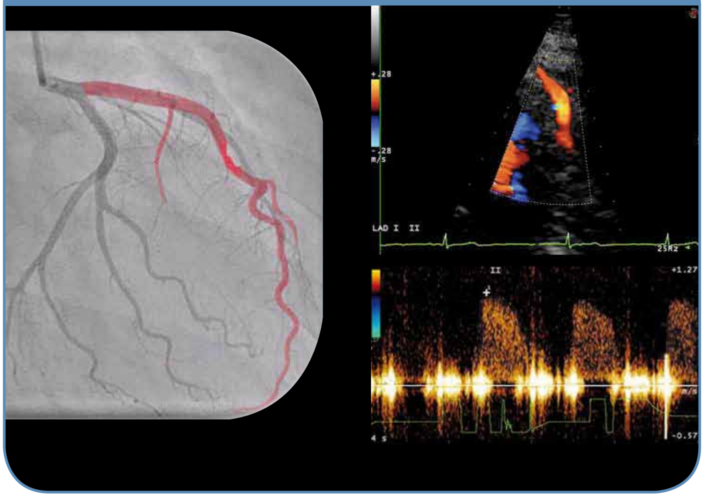
CT scan angiography shows promise for probing coronary anatomy non-invasively[6]. Molecular imaging aims to interrogate functional aspects of atherosclerotic lesions that go beyond mere anatomical features, including aspects of inflammation directly implicated in plaque stability and thrombogenic potential[24].

At least in the mid-term, cost-effectiveness and risk benefit analyses will probably favor a tiered approach for the deployment of imaging in cardiovascular risk assessment in apparently well individuals[6].

Coronary flow imaging

Recently, we were able to obtain important information regarding the influence of atherosclerotic coronary narrowing in a large number of patients, with the opportunity of validating this technique by matching data with those obtained by Doppler flow wire. We have already validate the coronary flow velocity mapping on left anterior descending coronary artery by matching this data with coronary angiography[25].

LAD Coronary Flow measurement



Doppler-derived coronary flow assessment on left anterior descending coronary artery (LAD) could represent an effective diagnostic modality in highlighting the presence of a pathological coronary narrowing.

The usual risk factors for CAD were little use in predicting obstructive CAD at angiography.

Each carotid parameter (c-IMT and c-plaques) had increased diagnostic value. A LAD velocity > 70 cm/sec, found at any site, was the most predictive parameter, building a significant additional diagnostic value for the prediction of CAD.

Integrated ultrasound investigations

The integrated ultrasound study represents a faster and easier way to investigate those asymptomatic patients with an intermediate risk for atherosclerosis.

The novelty could be represented by the possibility of investigating the subject during a single cardiovascular investigation by the same physician who, through the application of innovative technology, is able to assess the carotid artery, cardiac function by analyzing the left ventricle deformation indexes and coronary flow velocity mapping on the left anterior descending coronary artery.

From this combined evaluation we could get important and complementary information in order to stratify and to individualize personal risk and therefore to apply an individual and tailored prevention strategy.

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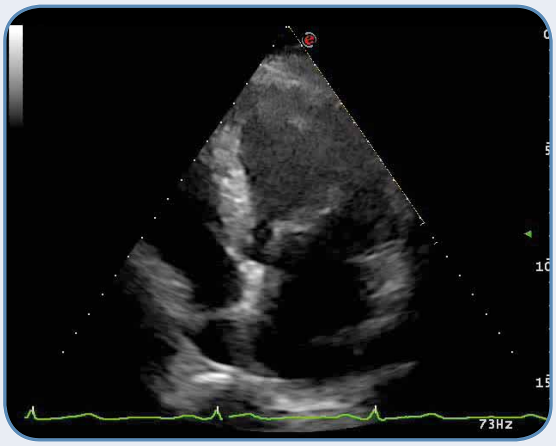
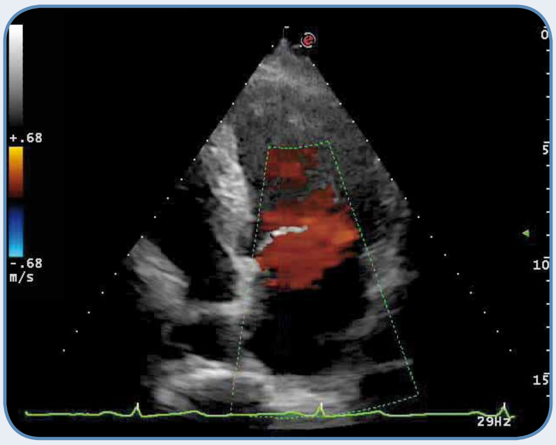
Case Study

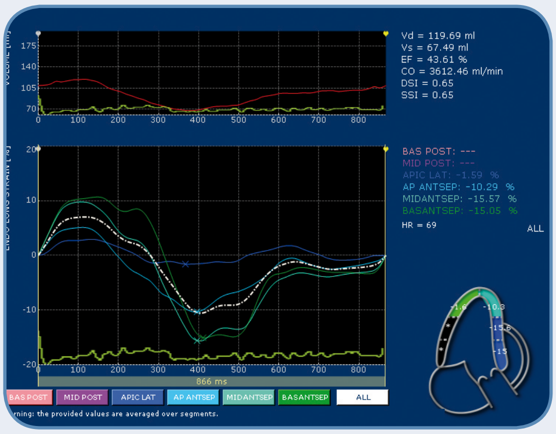
63 year-old male, Hypertension, LDL 164 mg/dl, ECG: SR LVH RA, No symptoms



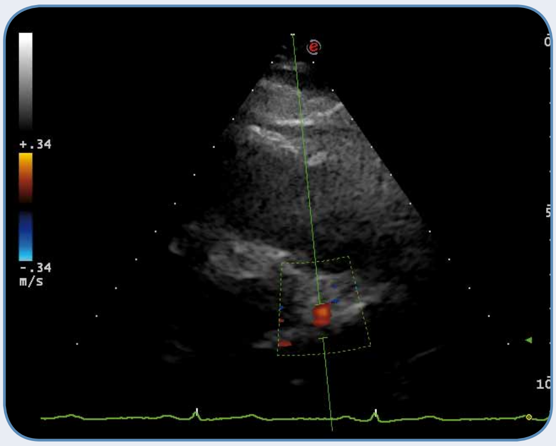
Echo TTE approach apical 4 chamber view during diastolic phase displaying a hypertrophic and slightly dilated left ventricle.

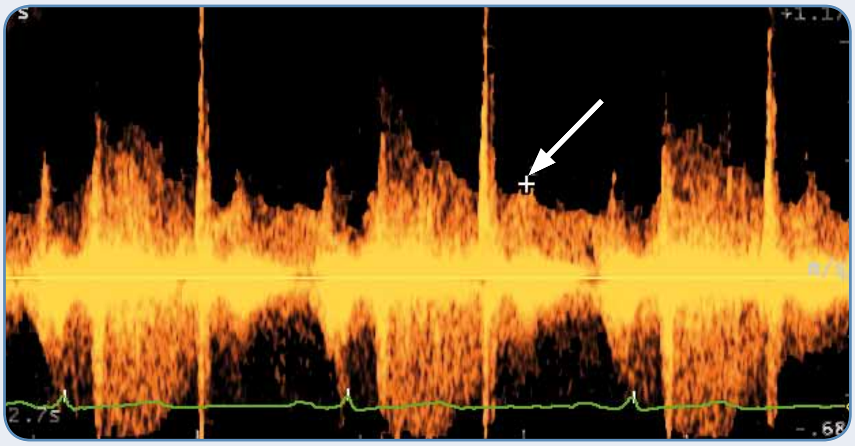


Echo TTE approach apical 4 chamber view during systolic phase displaying left ventricle with decreased global contractility (EF 40%).

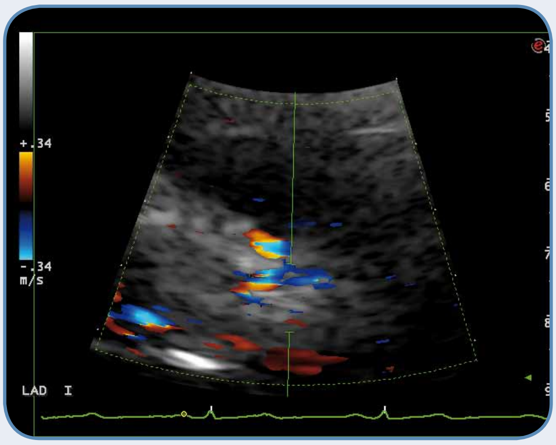


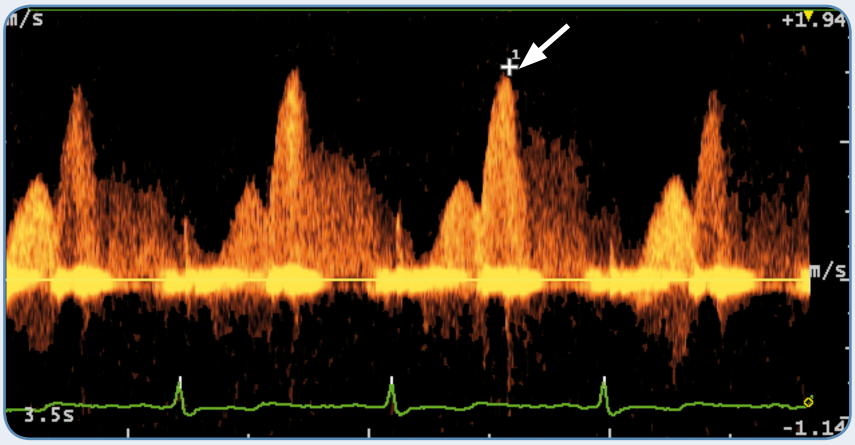
Longitudinal Strain reduced in all segments falling into LAD Territories , particularly depressed are Apical Lateral (-1,59) and Antero-septal (-10,29).



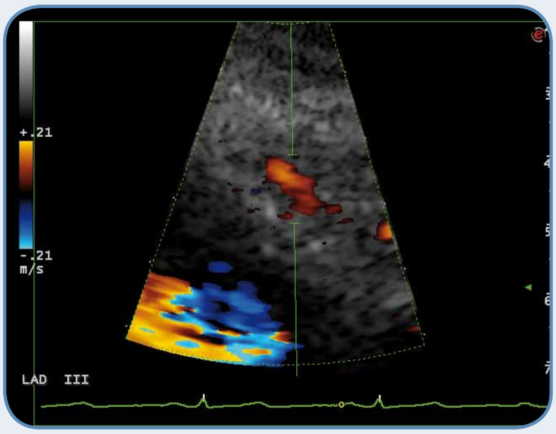


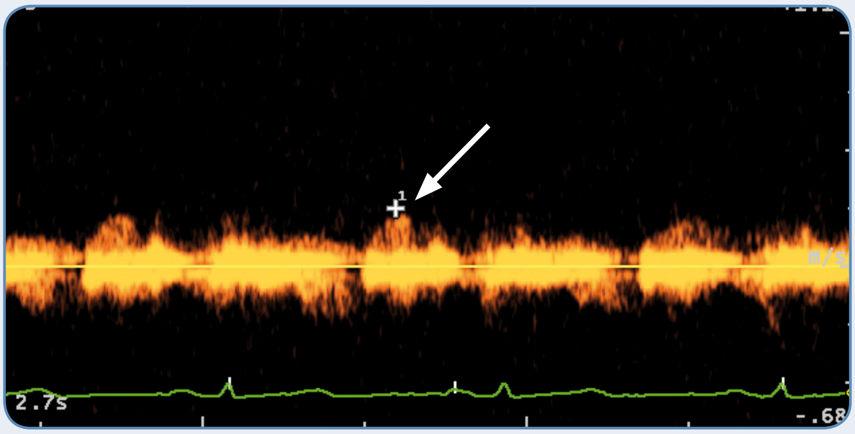
To the left - Color Doppler approach which allows to identify left anterior descending (LAD) coronary artery tract. To the right - Doppler spectral recording of LAD's first section with a flow rate of 40 cm/s, a normal velocity for this coronary segment.





To the left - middle tract of LAD with aliasing demonstrating high sampling rate. To the right - equivalent Pulse Doppler spectral recording displays a clear pathological flow rate between first and second LAD tracts demonstrating that this segment's flow undergoes a clinically significant sudden acceleration.



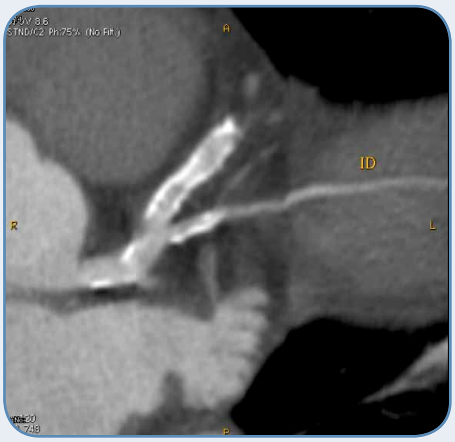


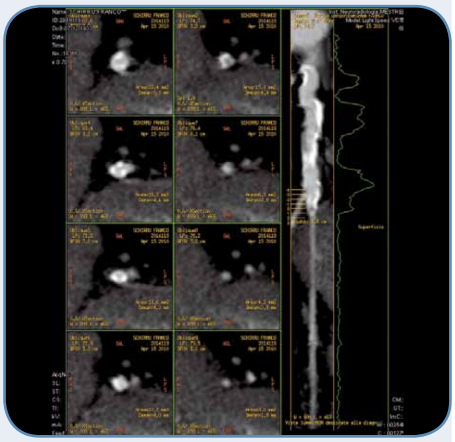
To the left - The red color signal of LAD's distal portion with Color Doppler approach witnessing that flow rate is within physiological sampling range as evidenced, to the right, by the equivalent Doppler spectral recording displaying normal flow rates.

Case Study

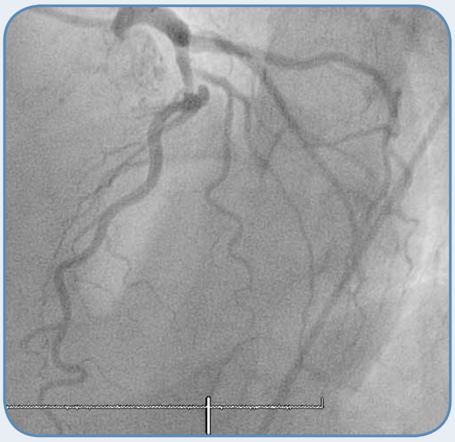
Left panel: A CT Scan multislice heart examination addressed to the first tract of left anterior descending coronary artery which shows a narrowing poorly quantifiable for the presence of a higher value of calcium score (> 400 CS)

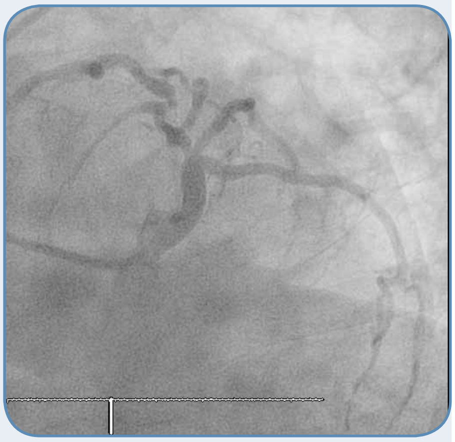
Right panel: same image acquired with multislice CT displaying anterior coronary vessel stenosis, probably > 50%, where an accurate diagnostic assessment of stenosis' severity is not possible due to calcification.





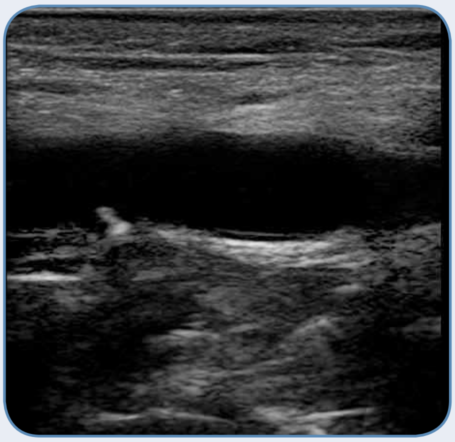
Left and right panels: A coronary angiography addressed to LAD, from different approaches, that highlights a critical stenosis of the first tract of LAD.

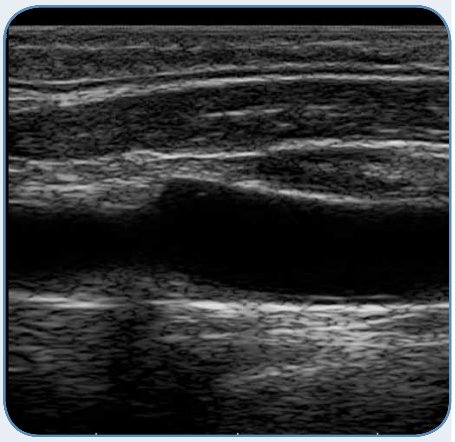




Left panel: Two-dimensional echocardiographic image displaying a significant amount of a plaque at the entrance of the left common carotid

Right panel: Two-dimensional echocardiographic image displaying a pathological increase in right common carotid IMT and intermediate plaques in the same segment.





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