Application of Echocardiography in Clinic Practice

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Echocardiogram is a totally non-invasive ultrasound assessment of the heart and the big vessels. It differs from ordinary ultrasound scan by providing information on
1. function, both dynamic systolic and diastolic
2. haemodynamics
3. anatomy
of the heart and related big vessels.

Echocardiogram can be performed under resting condition as baseline comprehensive assessment, or under controlled stress condition for functional assessment of significance of valvular lesion or inducible ischaemia in coronary artery disease.

In this short article, we shall discuss some of the applications of echocardiography in common problems in clinic practice.

A. Assessment of chest pain symptom
Symptom of chest pain is a common presenting symptom in clinics. The list of possible causes from any medical textbook includes
a. coronary artery disease
b. aortic dissection
c. pulmonary embolism
d. peptic ulcer disease
e. reflux oesophagitis
f. musculoskeletal pain
g. pleuritis / pericarditis
h. neuritis
i. gall stone
j. psychosomatic etc

Most of the time clinicians want to rule out coronary artery disease and aortic dissection etc as they are treatable and carry most of the prognosis. A comprehensive echocardiogram can give us clues and even make the diagnosis of acute coronary syndrome, aortic dissection or pulmonary embolism. (Fig. 1)

Regional wall motion abnormality and thinning indicates old myocardial infarction or significant ischaemia at rest. Although Treadmill ECG is usually ordered to look for possible ischaemia, an exercise stress echocardiogram is usually more helpful and accurate in diagnosis and risk stratification.

Traditional Treadmill ECG uses ST segment changes as an indicator of underlying myocardial ischaemia. However Treadmill ECG has limited sensitivity in pre-menopausal women because of their lower prevalence of coronary artery disease. Moreover, common baseline ECG abnormalities like bundle branch block, left ventricular hypotrophy, digoxin or simple non-specific ST segment or T wave abnormality can make subsequent ECG changes non-specific to ischaemia and the whole test inconclusive.

Exercise stress echocardiogram uses direct visualisation of the LV wall motion as a marker of inducible ischaemia. Wall motion abnormality occurs earlier in the ischaemic cascade and this makes the test more sensitive and specific (overall sensitivity 85%, specificity 80%) and equivalent to nuclear myocardial perfusion scan. The advantages of exercise stress echocardiogram are cost-efficient, no need of contrast or radiation exposure and high acceptability to the patient. The patient can be informed of the result right after the test in the clinic. Apart from diagnosis, it stratifies patients into different risk categories and prognosticates.

B. Assessment of exertional shortness of breath or decrease in exercise tolerance
Exertional shortness of breath or subjective decrease in exercise tolerance is another common presenting symptom in clinical practice. The causes can be divided into three categories (1):

a. cardiac causes like systolic or diastolic heart failure
b. pulmonary causes like COAD, fibrosis, pleural effusion etc
c. systemic causes like anaemia, thyrotoxicosis etc

A detailed history and examination can rule out most of the systemic and pulmonary causes. A comprehensive echocardiogram is indispensable in the diagnosis of cardiac causes of exertional shortness of breath.

Most practitioners focus only on the ejection fraction (EF) of the Echocardiogram report. A low EF suggests systolic heart failure is a possible cause for the patient's symptom. However, more than 40% of patients suffer from diastolic heart failure with normal ejection fraction > 50%. (Fig. 4)

Diastolic heart failure means the heart needs to be filled with increased pressure (elevated LV end-diastolic pressure). In the old days, diagnosis can only be arrived at by invasive cardiac catheterisation. However, nowadays non-invasive echocardiographic assessment has been considered the choice and tool in diastolic cardiac assessment for clinical studies and cardiology practice.

I do not intend to discuss cardiac diastology in this short article as it is more complex than simple systolic ejection fraction. Patients with systolic heart failure
usually complain with fatigue due to inadequate cardiac output. On the other hand, patient with diastolic heart failure has dominant "congestive" symptom either shortness of breath, orthopnoea or ankle oedema.

LV diastolic dysfunction can be classified into stages (Fig. 5)

a. Stage 1 : impaired LV relaxation, a stage with minimal symptom at rest but disproportional shortness of breath due to elevated filling pressure when tachycardia sets in during exertional or atrial fibrillation
b. Stage 2 : pseudo-normalisation, a stage with exertional SOB on minimal exertion due to elevated filling pressure at rest
c. Stage 3 and stage 4 : reversible and irreversible restrictive , the advanced stages of diastolic dysfunction with severe symptoms even at rest and poor prognosis.

Diastolic heart failure is indeed common and an usually missed diagnosis. Hypertension and coronary artery disease are two common causes of LV diastolic dysfunction. Hypertension causing left ventricular hypertrophy is the commonest cause of increased LV stiffness thus impaired relaxation.

By applying Doppler study on trans-mitral inflow, pulmonary venous inflow and Spectral Tissue Doppler (TDI) on mitral annular velocity, previously complex diastolic parameters can easily and quickly be elucidated. Practitioners do not need to memorise all these terminology but it is the duty of the reporting cardiologist to comment on the ventricular diastolic function and evidence of elevated filling pressure in a comprehensive echocardiogram. (Fig. 4)

Treatment of diastolic dysfunction needs to be individualised and will not be discussed here.

C. Incidental findings of heart murmur, abnormal ECG or cardiomegaly on CXR

An incidental finding of possible cardiac abnormality is a common result of cardiac consultation.

1. Heart murmurs can be functional, but can also be the first abnormal finding in a patient with significant structural heart disease. The characters of a typical functional heart murmur are ejection in nature; of soft character ( grade 1 to 2 over 6 ); localised at left sternal border, changes with position and with no other cardiac abnormalities detected on examination. A diastolic murmur is never functional even though it may not be significant. The American College of Cardiology class 1 and 2 indications to comment on the ventricular diastolic function and evidence of elevated filling pressure in a comprehensive echocardiogram.

2. ECG abnormality

ECG finding of left ventricular hypertrophy (LVH) or right ventricular strain pattern are indications for Echocardiogram. ECG voltage criteria of LVH is less specific than direct LV wall thickness and LV mass measurement by echocardiogram. High QRS voltage without LVH is seen in young and slim individuals. Abnormal right ventricular depolarisation signal from ECG can be an early sign in patients with potentially fatal arrhythmogenic right ventricular dysplasia (ARVD ). Severely abnormal Echocardiographic findings are major criteria for such clinical diagnosis. Moreover, incidental finding of "pathological Q" wave needs corresponding echocardiographic findings for confirmation of old transmural myocardial infarction.

3. Incidental finding of cardiomegaly on CXR

Causes of cardiomegaly on CXR can be due to

a. left ventricular dilatation
b. right ventricular dilatation
c. left, right or biatrial enlargement
d. underlying valvular heart disease causing such chamber dilatation
e. pericardial effusion
f. composite shadow from the lung without true cardiac abnormality

A simple resting comprehensive echocardiogram is an indispensable test for such differentiation.
References


2. The ACC/AHA 2002 Guideline Update for Exercise Testing


