The apex beat

What is the apex beat?

The cardiac apex beat, also known more descriptively as the point of maximal impulse, corresponds to the most inferolateral point at which the cardiac pulsation can be palpated. It is a normal clinical sign in most patients but may provide valuable information about underlying cardiac disease in others. With the increasing availability of investigations such as echocardiography, cardiac computed tomography and magnetic resonance imaging, the careful elucidation of cardiovascular signs, such as the cardiac apex beat, has become an often-neglected part of the cardiovascular examination. However, in postgraduate clinical exams, such as the Membership of the Royal College of Physicians practical assessment of clinical examination skills (MRCP PACES), the candidate must use all available clinical signs when formulating diagnoses.

History

The first recorded description of the cardiac apex beat was by William Harvey in the 17th century. He described the apex beat in his pivotal text, *On the Motion of Heart and Blood in Animals*, and was the first to suggest that the palpable cardiac pulsation was caused by the apex of the heart, rising in systole, hitting the anterior chest wall (Harvey, 1889).

What to do in your examination

1. Lie the patient at 45° or, more ideally, in the left lateral position
2. Palpate for the apex beat with two fingers (*Figure 1*)
3. Note the character, size, magnitude and volume of the pulsation
4. Note the location of the apex beat by using the angle of Louis (or the sternal angle; the junction of the sternum and manubrium sterni, at the level of the second rib) as a reference point (*Figure 1*).

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What is the physiology?

The apex beat is the 'lateral and inferior most point on the praecordium where the cardiac impulse can be palpated' (Douglas et al, 2009). The apex beat is normally located in the left, fifth intercostal space in the mid-clavicular line (*Figure 1*). Since this point reflects the position of the cardiac apex, it is also the 'window' used to acquire the apical (four and five chamber) views in echocardiography.

The location, character, size, magnitude and duration of the apex beat is variable. Each variation may have multiple causes so it is important to interpret within the context of the remainder of examination findings. Individual clinical signs should be used to strengthen or oppose a diagnosis. Placing too much emphasis on individual signs is a common exam pitfall. *Table 1* summarizes apex beat abnormalities, potential causes and tips for differentiation.

Interpretation of clinical findings

Impalpable apex beat

This is a normal phenomenon in 50% of healthy patients but is more common in the context of obesity, where adiposity masks the impulse, and in those patients with chronic lung disease, where the hyper-inflated left lung may interpose between the heart and the anterior chest wall. It is also associated with pericardial effusion, which is uncommon in exams, and with left pleural effusion, which is more common.

An impalpable apex beat is also associated with dextrocardia which, although uncommon in clinical practice, is over-represented in clinical exams. Lying a patient in the left lateral position may be enough to unmask an apparently impalpable apex.

Figure 1. How to examine the apex beat with the patient positioned at 45°. a indicates the sternal angle (angle of Louis) corresponding to the second intercostal space laterally, b indicates the left clavicle, c indicates the mid-clavicular line.

Displaced apex beat

Many disorders may result in a displaced apex beat. Left inferior displacement is more common than right displacement. The commonest cause of displacement is a skeletal abnormality such as scoliosis or pectus excavatum. Any cardiac condition resulting in left ventricle dilatation (but not hypertrophy) may result in lateral displacement. The heart itself may be pushed or pulled, right or left, by primary respiratory conditions such as pneumothorax, pleural effusion and lung collapse. In these conditions, the trachea and mediastinal structures will also be shifted. Rarer causes of displacement include pregnancy (secondary to the gravid uterus) and dextrocardia where the apex will be in the right, fifth intercostal space.

Tapping apex beat

A tapping apex is typically found in mitral stenosis and represents a palpable first heart sound (S1). Obstruction of atrioventricular blood flow results in elevated left atrial pressures which delay mitral valve closure. Instead of the valve 'gliding' shut at end-diastole, the thickened leaflets are abnormally 'slammed' shut under high pressure at the start of ventricular systole. The closure of the valve cusps resonates through surrounding tissues and this radiates into the anterior chest wall.

Thrusting apex beat ('hyperdynamic' apex beat)

A thrusting apex beat results from left ventricle volume overload and is the result of an increase in stroke volume. Left ventricle volume overload commonly results from aortic or mitral regurgitation or from bradycardia (prolonged diastolic filling resulting in increased stroke volume). It is also found in hyperdynamic states such as sepsis, thyrotoxicosis and anaemia.

Table 1. Types of apex beat abnormality and the potential causes

Abnormality	Description	Causes		Differentiating from other causes
Impalpable	Normal in ~50%	Obesity		Bedside visual assessment
		Chronic lung disease		Hyper-expanded chest
		Left pleural or pericardial effusion		Dull left base or quiet heart sounds
		Dextrocardia		Apex present on right (fifth space)
		'Hidden' behind a rib		N/A
Displaced	Left or inferiorly	Left ventricle dilatation	Dilated cardiomyopathy	Look for other signs of decompensated heart failure
	Right or left	Musculoskeletal abnormality	Ankylosing spondylitis	Bedside visual assessment
			Kyphoscoliosis	Bedside visual assessment
			Pectus excavatum	Bedside visual assessment
	Left	Intrathoracic disorder	Right tension pneumothorax	Displaced trachea or hyperesonant right chest
			Large right pleural effusion	Dull right base
			Lobar collapse	Displaced trachea or increased vocal resonance
	Right	Other		
	Left	Dextrocardia (right fifth space)		Apex present on right (fifth space), look for signs of Kartagener's syndrome
		Pregnancy		Bedside visual assessment
Tapping	Undisplaced, palpable S1	Mitral stenosis		Rumbling mid-diastolic murmur, malar flush
Thrusting (volume loaded left ventricle)	Forceful	Aortic regurgitation		Wide pulse pressure, collapsing pulse
		Mitral regurgitation		Pan-systolic murmur
	Ill sustained	Bradycardia		Pulse assessment
		Sepsis		Tachycardia, hypotension, fever
		Thyrotoxicosis		Thyroid assessment
		Anaemia		Tachycardia, pale conjunctiva, breathlessness
Heaving (pressure loaded left ventricle)	Forceful, sustained	Aortic stenosis		Ejection systolic murmur radiating to carotids
	Undisplaced	Aortic coarctation		Radio-femoral delay and upper limb hypertension
	Lifts hand noticeably	Systemic hypertension		Remember to check blood pressure
Double impulse	Undisplaced	Hypertrophic obstructive cardiomyopathy		'Jerky pulse', valsalva manoeuvre increases intensity of murmur
Diffuse	Palpable over >3 cm	Left ventricle aneurysm		Look for signs of cardiovascular risk factors such as tobacco staining and xanthelasma
		Severe left ventricular systolic dysfunction		Look for other signs of decompensated heart failure

Sustained apex beat ('hyperkinetic' or heaving apex beat)

A sustained apex beat results from sustained cardiac systole which, contrary to the thrusting apex beat, results from pressure overload. This is explained by the fact that it takes longer to overcome the increased afterload and so the ejection of blood is delayed and prolonged. Conditions associated with raised left ventricle afterload include aortic stenosis, sub-valvular aortic stenosis, aortic coarctation and hypertension. Equally, cardiomyopathy results in a weaker left ventricle contraction and thus a lower left ventricular systolic pressure relative to the (normal or low) left ventricle afterload. The same biomechanical reason therefore explains why this sustained apex beat is also associated with cardiomyopathy.

Double apex beat

A double impulse is associated with hypertrophic obstructive cardiomyopathy. In hypertrophic obstructive cardiomyopathy, left ventricle outflow tract obstruction is dynamic, i.e. it occurs towards late systole. This gives the systolic motion of the heart a jerky 'double' movement which can occasionally be palpated. It is associated with a jerky character to the carotid pulse. A double apex beat may also be palpated in mixed aortic valve disease (severe) which will be accompanied by a bisferiens pulse (Finegold and Pantazis, 2011).

Diffuse apex beat

The normal apex beat is localized to one intercostal space and is normally restricted to a width of ~3 cm. A diffuse apex beat is felt in more than one intercostal space and/or over a width >3 cm. Diffuse apex pulsation is associated with left ventricular dilatation and left ventricular aneurysm (which may also be palpated as a double impulse).

Is there any evidence?

Clinical examination technique and interpretation of the apex beat has been taught for decades but is there any evidence supporting its use?

A systematic review by Madhok et al (2008) looked at 10 000 patients in 24 studies. The reliability of history, examination, electrocardiogram, chest radiography and natriuretic peptides in predicting left ventricular systolic dysfunction was investigated with echocardiography being used as the gold standard. Of all the factors assessed, a displaced apex beat showed the highest diagnostic accuracy (positive likelihood ratio = 16) and outperformed signs such as raised jugular venous pulse and peripheral oedema.

Davie et al (1997) studied 259 breathless patients, of which 41 had left ventricular systolic dysfunction (by echocardiographic criteria). A displaced apex beat was found to be a more reliable predictor of left ventricular systolic dysfunction than any other clinical sign (sensitivity 66%, specificity 96%, positive predictive value 75%).

Two studies by Ehara et al (2010, 2011) investigated the nature of the apex beat in the context of cardiac multi-slice computed tomography. A sustained or double apical impulse was highly specific (90%) for left ventricular hypertrophy and the size and position of the apex beat was found to reflect the position of the cardiac apex.

Logar et al (2011) found that an apex beat palpable over an area of > 4 cm of the praecordium was a more reliable sign of left ventricular dilatation than the location (sensitivity and specificity 96%) in his echocardiographic study of 100 patients. Similarly, a study of 721 patients demonstrated that a displaced apex beat was the single most useful clinical examination sign when diagnosing heart failure (Kelder et al, 2011).

Conclusions

The apex beat is a useful but oft-neglected clinical sign in the context of modern, investigation-dependent medicine. However, it can yield useful information when formulating diagnoses especially in postgraduate exams like the MRCP PACES. Furthermore there are data in the literature which validate its use, especially in supporting a diagnosis of left ventricular systolic dysfunction. As with all clinical signs, it must be interpreted in the context of the remainder of the examination findings. **BJHM**

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KEY POINTS

- The apex beat is impalpable in up to 50% of normal healthy patients but this is more common in patients who are obese and those with chronic lung disease.
- Lying the patient in the left lateral position may unmask a previously impalpable apex beat.
- Common causes of apex beat displacement include musculoskeletal abnormalities and left ventricular dilatation.
- There is a strong evidence base to support the use of the apex beat in cardiovascular examination.
- If the examination is normal, but the apex beat cannot be located, a quick check for dextrocardia is warranted.