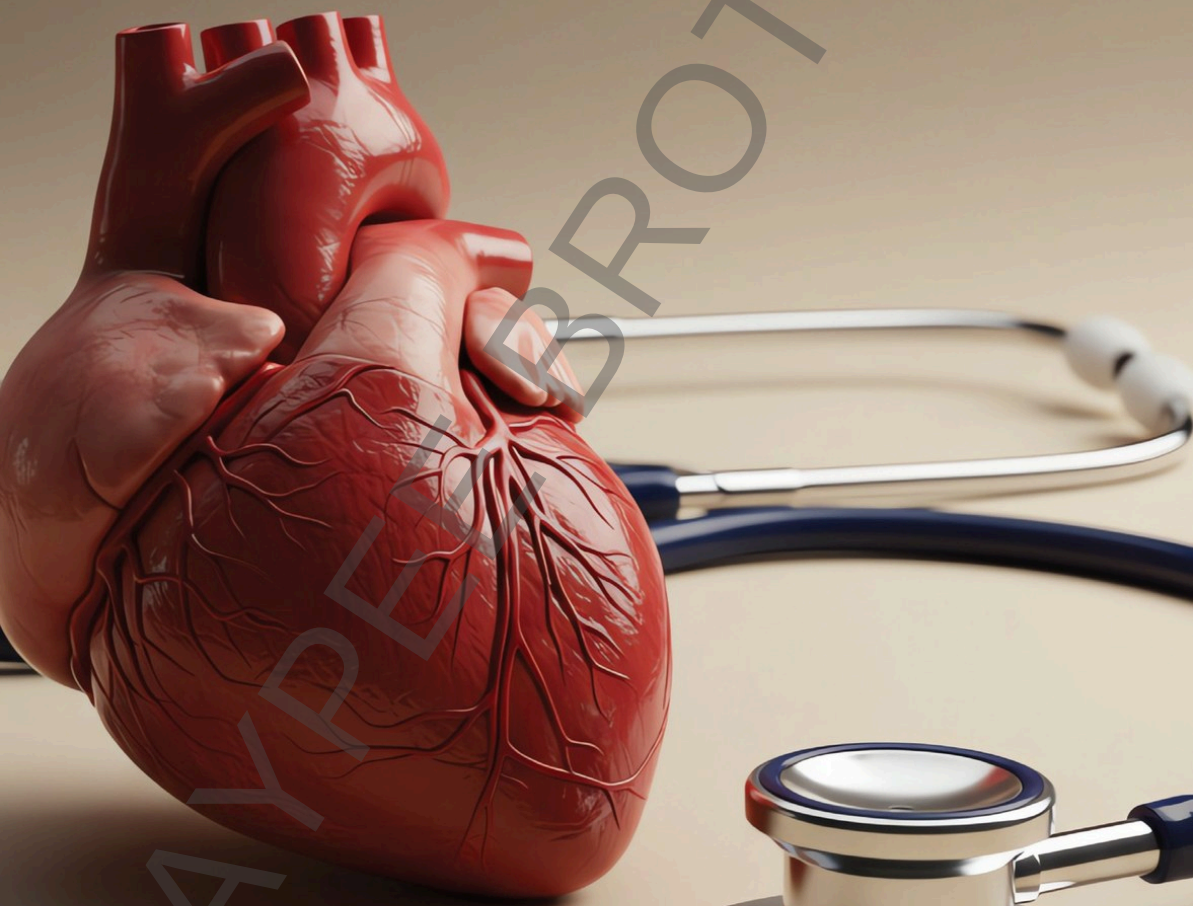
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2nd Edition

CARDIOLOGY

Clinical Methods



Editors
V Jacob Jose
S Ramakrishnan

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CHAPTER 5

Precordial Examination: Palpation

Oommen K George

CHAPTER OUTLINE

- Apex Beat
- Point of Maximal Impulse
- Character of Apical Impulse
- Parasternal Lift
- Epigastric Impulse
- Pulmonary Artery Impulse
- Aortic Impulse
- Thrills
- Palpable Sounds

INTRODUCTION

For optimal precordial examination, the room should be comfortably warm. The patient should be lying comfortably in the supine position or with the thorax elevated not >30°.

Both the palm of the hand and the ventral surface of the proximal metacarpals and fingers should be used for palpation. The palm and the proximal metacarpals are preferred for initial localization of palpable cardiac motion and pads of fingers for precise localization and assessment of the impulse.

The pads of the fingers are most useful for detecting left ventricular (LV) and normal right ventricular (RV) motion. The palm and proximal metacarpals are usually best used for palpating larger, low frequency movements such as the parasternal lift of RV hypertrophy. Varying pressure with the hand is useful. High frequency movement such as ejection sounds, valve closure sounds, and mitral opening snaps are better detected with the handheld firmly against the chest, while low frequency movements such as ventricular diastolic filling events are best recognized with the fingertips. These subtle low frequency motion of a palpable third heart sound (S3) or fourth heart sound (S4) or double systolic apical impulse will be felt only with light pressure of the fingers and may be missed, if palpated otherwise.

Before beginning systematic palpation, it is useful to observe the precordium for movements that are obvious at a glance. These movements can be enhanced by applying pen marks on the skin at the site under observation and by using a source of oblique illumination. The examiner should then look tangentially rather than from above. Parasternal movements are sometimes best seen when the examiner looks upward from

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the patient's feet. Precordial retraction is more readily seen than palpated, whereas outward displacement is more readily palpated than seen.

Timing of precordial events is best carried out using simultaneous palpation of the carotid arterial pulse with the left hand. Some find that concomitant auscultation of first heart sound (S1) and second heart sound (S2) is useful for timing purposes. Actual observation of the stethoscope head positioned directly on the apical impulse can help in identifying systole; S1 and early ejection occur synchronously with anterior motion of the stethoscope head.

In assessing the movements of the heart imparted to the chest wall, it is necessary to determine the *topographic location* of a given impulse as well as its *timing* in the cardiac cycle (early, mid or late systolic, or diastole), its *duration* (how much of the cardiac cycle the impulse occupies), its displacement *characteristics* (vigor of movement, amplitude, and contour), and the maximum area occupied by the impulse (especially the LV impulse).

Palpation of the following seven areas may be carried out systematically:

- Apical impulse—point of maximal impulse (PMI)
- Para sternal lift
- Epigastric area
- Pulmonary area
- Aortic area
- Sternoclavicular area
- Ectopic pulsations if any

APEX BEAT

Definition

The apex beat, otherwise called cardiac impulse or apical thrust, is normally produced by LV contraction. ***It is the lowermost and outermost point of definite cardiac impulse, which imparts a perpendicular thrust to the palpating finger.***

Mechanism

The palpable apical impulse in a normal subject is produced by an anterior movement of the LV during early systole. During the isovolumic contraction, ***the LV rotates in a counterclockwise direction along its long axis, and the juxta-apical region lifts and makes contact with the anterior chest wall.***

Angiographic studies suggest that the interventricular septum (IVS) and the anteroseptal aspect of the LV make contact with the inner thoracic cage to form the palpable apical impulse. Following aortic valve opening, after the first half of ejection, the LV chamber moves away from the chest wall, and the ventricle continues to decrease in size until systole is completed. Thus, the impulse felt on the precordium is comprised of an early, outward thrust,

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followed by retraction during the last part of systole. The retraction wave can be seen but is not felt.

Diastolic events, such as those produced by rapid LV filling (S3), or left atrial contraction (S4), are normally not palpable. With alterations in ventricular diastolic volume, pressure, or compliance, these events can be transmitted to the chest wall and may be felt by the examining fingers.

In the normal heart, the *apex* is on the left. The *inflow or sinus portion* of the RV underlies the fourth and fifth left intercostal spaces (LICS), while the *outflow portion* (infundibulum) underlies the third left interspace. The border of the *right atrium* (RA) is just lateral to the lower right sternal edge, and the *aortic root* (ascending aorta) is convex to the right of the sternum at the level of the second right interspace. The left atrium is not border forming because it is a posterior structure, except for its appendage, which underlies the third left interspace.

Characteristics of a normal apical impulse:

- A gentle nonsustained tap
- Early systolic anterior motion that ends before the last third of systole
- Located within 10 cm of the midsternal line in the fourth or fifth intercostals space
- A palpable area <2–2.5 cm^2 and detectable in only one intercostals space
- RV motion is normally not palpable.
- Diastolic events are normally not palpable
- May be completely absent in older persons

Patient position: Palpation is best performed from the right side with upper trunk elevated at 30°, both with the patient supine and in the partial left lateral decubitus position. Rotating to left lateral decubitus position with the left arm elevated over the head causes the heart to move laterally and increases the palpability of normal and pathological thrusts of the left ventricle.

The LV impulse is difficult to identify in the sitting position. In an occasional patient who would have to be examined in the sitting position, the impulse if palpable, can be relatively confidently related to the landmarks described above for the supine position.

Location: Normally the LV impulse is medial and superior to the intersection of the left midclavicular line and the fifth intercostal space. In tall, thin persons, the apex beat can be distal (sixth interspace) and more medial than usual. In infants and in adults with short, stocky chests, the impulse is often in the fourth left interspace.

It is within 10 cm of the midsternal line.

Displacement of the apex beat lateral to the midclavicular line ***or >10 cm lateral to the midsternal line*** is a sensitive, but not specific ***indicator of LV enlargement***. The apical impulse may displaced upward and to the left by a high left diaphragm or during pregnancy. A tall, thin habitus has the opposite

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effect. Body build and thoracic configuration play a role in the displacement of the apical impulse. Scoliosis to the right rotates the heart leftward on its long axis; pectus excavatum shifts the heart to the left, altering the position of the normal LV impulse. A decrease in anteroposterior (AP) chest dimensions (loss of thoracic kyphosis or shallow, saucer-shaped pectus excavatum) increases contact of the RV with the anterior chest wall.

Size: In the supine patient, the apex usually measures <2.5 cm and occupies only one interspace. In the left lateral decubitus position, ***diameter >3 cm is an accurate sign of LV enlargement.***

Duration: It is palpable as a single brief outward motion. It does not extend significantly into the LV ejection phase. The outward movement of the apical impulse is felt only during first third of systole. Peak outward motion of the apical impulse occurs coincident with or just after aortic valve opening and the beginning of ejection. The beginning of the LV ejection at the bedside is appreciated by the onset of the carotid pulse upstroke. The impulse is sustained for a brief period (up to 0.08 seconds) and then the outward movement ceases as the LV apex moves inward. The normal outward movement of the LV apical impulse recedes from the chest wall and becomes impalpable with the onset of ejection following the upstroke of the carotid pulse and during the downstroke of the carotid pulse. Thus, at the bedside when carotid pulse and LV apical impulse are examined concurrently, these two impulses appear out of phase or asynchronous.

Amplitude: In normal individuals, the apex beat is a gentle outward motion. There may be respiratory alterations in the amplitude of the apex beat. Pay attention to the end of expiration if the impulse is hard to locate, although the peak amplitude may also occur during early inspiration.

Many older individuals do not commonly have palpable cardiac activity in the supine position. This may be due to an age-related increase in the (AP) thoracic diameter, an increase of muscle or fat on the chest wall. In most adults, LV activity can be detected when the subject is turned on to the left side, particularly in expiration. The causes of nonpalpable apical impulse are obesity, muscular chest wall, barrel chest, emphysema, coronary artery disease (CAD) with decreased apical motion, pleural or pericardial effusion, and age over 50 years.

Normal but hyperkinetic impulse: In anxious patients, there is often an increase in both the velocity and amplitude of the impulse, but not in its duration or area.

POINT OF MAXIMAL IMPULSE

It need not necessarily be the apex beat, since the maximal precordial pulsation may be produced by an enlarged or hypertrophied RV, a dilated aorta or pulmonary artery, or a LV wall motion abnormality.

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CHARACTER OF APICAL IMPULSE

The character of apical impulse is described in one of the following ones:

- **Normal**
- **Hyperkinetic**
- **Sustained**
- **Late systolic**
- **Hypokinetic**

Sustained Apical Impulse

The LV heave or lift, which is more prominent in concentric hypertrophy, is characterized by a sustained outward movement of an area that is larger than the normal apex, i.e., >2–3 cm in diameter and occupies more than one intercostal space. It is characterized by a prolonged **duration** of the outward movement extending into the ejection phase of the left ventricle. When the carotid pulse upstroke and duration are evaluated simultaneously with the LV outward movement, the sustained apical impulse appears in phase with the carotid pulse upstroke and remains palpable during the down stroke of the carotid pulse. Often lasting up to the second heart sound, and this motion is accompanied by retraction of the left parasternal region. This rocking motion can often be appreciated by placing the index finger of one hand on the apex beat and that of the other hand in the parasternal region and by palpating the simultaneous outward motion of the former while observing retraction of the latter **(Fig. 1)**.

Hyperdynamic Apical Impulse

There is increase in the **amplitude** of the LV impulse without a change in contour. The sequence between the onset of the carotid and the outward movement remains normal. It is appreciated as thrust of large amplitude that

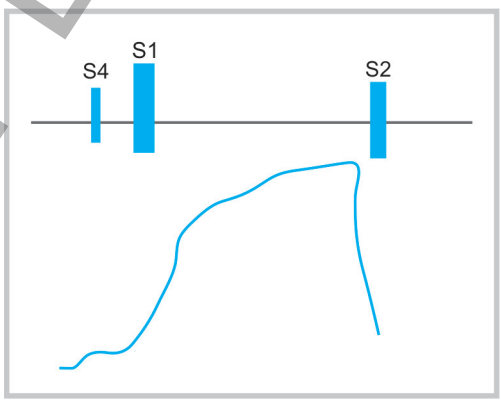


Fig. 1: Schematic representation of sustained apical impulse.

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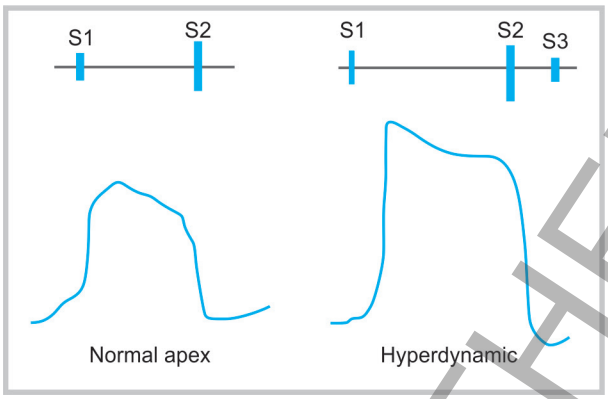


Fig. 2: Schematic representation of normal and hyperdynamic apical cardiac impulse.

immediately disappears from the palpating fingers. When the duration of the ejection phase is estimated from the carotid pulse upstroke and down stroke or from the interval between first and second heart sound, the hyperdynamic apical impulse does not extend throughout the systole **(Fig. 2)**.

Hypokinetic Impulse

This is found in patient with reduced stroke volume, especially in acute myocardial infarction or dilated cardiomyopathy.

A sustained low amplitude impulse is called hypokinetic impulse. A hypokinetic LV impulse (low velocity and amplitude of systolic motion) is generally accompanied by reduced velocity and amplitude of medial retraction.

Ectopic Impulse

Left ventricular aneurysm may produce a sustained systolic bulge several centimeters superior to the LV impulse, sometimes termed an *ectopic impulse*. It can be associated with a systolic impulse in unusual location such as over the mid-precordium. The most common site of an ectopic impulse is above and medial to the expected location of the LV impulse. The ectopic segment, often as readily seen as palpated, is usually caused by the anterior wall dyskinesia of CAD. LV aneurysm produces a larger than normal area of pulsation of the LV apex.

An anterolateral or apical aneurysm may be felt best at the apex, but an anterior aneurysm may be felt several centimeters away from the apex. Some patients with dyskinetic left ventricles may have two distinct areas of rocking movement separated by several centimeters. Patients with LV aneurysm will have palpable "a" wave, and thus a double apical impulse.

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Anterior systolic movement of a normal RV can be caused by certain regional wall motion abnormalities of the LV. Dyskinetic motion of the ventricular septum during angina pectoris displaces the RV forward and results in a transient left parasternal impulse that disappears with relief of angina. In patient with angina pectoris, early systolic, late systolic or combined early and late systolic bulges can be occasionally appreciated at the bedside. If these abnormal apical impulses are transient and appreciated during anginal pain, reversible myocardial ischemia should be considered. This prolonged systolic impulse of regional dyskinesis is really "paradoxical" because it bulges abnormally during mid to late systole, at a time when normal, earlier anterior systolic movement has ceased.

Hypertrophic obstructive cardiomyopathy (HOCM): A double systolic outward thrust of the left ventricle is characteristic of the patients with HOCM, who may also often exhibit a typical presystolic cardiac expansion, thus resulting in three separate outward movements of the chest wall during each cardiac cycle.

Constrictive pericarditis: When the left ventricle occupies the cardiac apex, but the apex retracts in systole, the cause is usually chronic constrictive pericarditis. Retraction is usually most pronounced at the apex, but may extend as far as the left sternal edge. It is also characterized by systolic retraction of the ribs in the left axilla (***Broadbent sign***). Prominent early diastolic LV filling in constrictive pericarditis may be palpable. The precordial diastolic movement in chronic constrictive pericarditis has been called "diastolic heartbeat". This is just as likely to be palpated over the RV as over the LV.

Diastolic motion: The outward motion of the apex characteristic of rapid LV diastolic filling is most readily palpated with the patient in the left lateral decubitus position and in full exhalation. This palpable equivalent of S3 is less often palpable than S4.

PARASTERNAL LIFT

Except in the first few months of life, right ventricle is not palpable. In children and in occasional adults with thin chest walls, a brief, gentle impulse may be palpable over the left third and fourth interspaces. This impulse is usually in diastole. Although the RV, located just beneath the sternum and left 3rd to 5th ribs, is closer to the chest wall than the left ventricle, RV activity is not normally felt. This is probably because the RV is thin walled (2–3 mm wall thickness), low pressure (20–25 mm Hg peak systolic pressure), and it pulls away from the anterior chest as the heart rotates in a counterclockwise fashion in early systole.

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Parasternal lift: The normal systolic retraction is replaced with a lift in the left parasternal region, best felt by the proximal palm or fingertips and with the patient supine, usually represents RV enlargement or hypertrophy.

- The patient should rest supine at 30°.
- It is desirable to use **held end expiration** movement for RV examination. Movements of the examining hands and fingers should be carefully observed, as the typical low amplitude RV activity is better seen than felt. RV abnormalities are only detectable in the supine position.
- Firm downward pressure with the hand on the lower left sternal area is usually necessary. Since RV activity is usually low amplitude, it will not be detected without such firm compression.

Two methods of RV palpation are recommended:

- The **heel of the hand** can be applied firmly to the left sternal edge during full expiration, keeping the fingers elevated while sensing the systolic impulse and observing the motion imparted by the RV contraction. This technique is relatively insensitive in detecting subtle systolic movement and does not localize the impulse so derived.
- A more refined method employs **several fingertips** applied simultaneously and in parallel in the third, fourth, and fifth intercostal spaces during held expiration. The free left hand is used for timing with the right carotid pulse as reference or by applying the stethoscope to the chest for the identification of the first and second heart sounds. This method of palpation not only permits detection of gentle RV systolic impulses but also localizes the movements to the inflow portion (fourth and fifth ICS) or infundibulum or outflow portion (third ICS). In infants, palpation along the left sternal border is achieved with the tip of a single finger during active breathing or during a very brief arrested respiration induced by pinching the nostrils while the infant sucks on a nipple or pacifier.

Causes of Parasternal Lift

Right Ventricular Volume Overload

- Exaggerated motion of the entire parasternal area (hyperdynamic impulse) usually reflects increased RV contractility due to augmented stroke volume as occurs in atrial septal defect (ASD) or tricuspid regurgitation (TR).
- *RV pressure overload:* A sustained left parasternal outward thrust reflects RV hypertrophy due to pressure overload, as in pulmonary arterial hypertension (PAH) or PS. Right ventricular failure (RVF) with reduced RV ejection produces a prolonged left parasternal impulse. When the RV is appreciably enlarged, it occupies the apex, displacing the left ventricle, which no longer makes contact with the chest wall and therefore imparts

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no precordial impulse. In this setting, RV systolic movement extends from the left sternal edge to the cardiac apex, which retracts. To confirm that the RV occupies the apex, observation of movement becomes important because lateral retraction is better seen than palpated.

- *Left atrial impulse:* Significant mitral regurgitation (MR) may cause left atrial expansion during LV systole producing a sustained left parasternal impulse. Thus at the bedside before the diagnosis of the RVF/RVH is suspected, it is necessary to exclude significant MR. In patients with RVH and RVF, however a sustained epigastric impulse is appreciated. The systolic bulging of the left atrium (LA), which is transmitted through the RV, commences and terminates after the LV thrust. Movement imparted by the systolic expansion of the LA can be appreciated by placing the index finger of one hand at the LV apex and the index finger of the other in the left parasternal region in the third intercostal space; the movement of the latter finger begins and ends slightly later than that of the former.

A giant left atrium may extend well into the right hemithorax, so MR can cause late systolic movement of the lower right anterior chest, occasionally as far as the right anterior axillary line. When MR occurs in the presence of a dilated left atrial appendage, an impulse is palpated and often seen in the third left interspace because the appendage is border forming at that site.

Dressler's Grading of Parasternal Lift

- *Grade 1:* Faintly felt
- *Grade 2:* Felt, seen, but can be obliterated with pressure.
- *Grade 3:* Cannot be obliterated with pressure.

EPIGASTRIC IMPULSE

In the subxiphoid region, for palpation of the right ventricle, use the tip of the **index finger during held inspiration**. This technique is particularly useful in patients with an increased AP diameter, chronic obstructive pulmonary disease (COPD), obesity, or a muscular chest, when RV enlargement is suspected, but a parasternal impulse cannot be felt. With the hand flattened the index finger should be pressed just under the rib cage and up toward the left shoulder. The examiner should be careful to differentiate the downward-directed motion of the enlarged RV from the anterior pulsations of the abdominal aorta, which can often be felt in the epigastrium. Palpable RV diastolic events are often best detected with this approach.

PULMONARY ARTERY IMPULSE

Pulmonary artery: The main pulmonary trunk (MPA) is border forming in the second left interspace. The impulse is often better seen than palpated,

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especially when observed during full held expiration with the site marked with an "X". In thin patients, especially with decreased AP chest dimensions, a normal pulmonary trunk sometimes transmits a visible and palpable impulse to the second left interspace prominent during full held expiration. PAH or increase in pulmonary blood flow (PBF) produces a prominent systolic pulsation of the pulmonary trunk in the second intercostal space just left of the sternum. This may be associated with a palpable shock synchronous with the second heart sound, reflecting forceful closure of the pulmonary valve.

AORTIC IMPULSE

Aorta: Sternoclavicular joint pulsations are rarely visible. They are generally subtle and are best sensed by relatively firm pressure with two apposed fingertips, which fix the point under examination. Enlargement or aneurysm of the ascending aorta or the aortic arch may cause visible or palpable systolic pulsation of the right or left sternoclavicular joint and may also cause a systolic impulse in the suprasternal notch or in the first or second right intercostal spaces.

However, the most common cause of the right supraclavicular pulsation is a kinked, tortuous right carotid artery. An abnormal pulsation of a sternoclavicular joint in patients with chest pain may be an early clue to diagnosis of aortic dissection. A slight pulsation in the right sternoclavicular area may suggest a right-sided aortic arch in patients with cyanotic heart disease.

Rarely, late systolic anterior movement of the sternum (and of the contiguous left parasternal area) is caused by a large, pulsatile descending aortic aneurysm as it physically moves the heart forward during ventricular systole. If this sign is suspected, a synchronous late systolic movement should be sought in the posterior thorax to the left of the vertebral column.

THRILLS

Definition: Thrills are palpable vibrations from the murmurs or bruit, ordinarily associated with grade 4/6 murmur or louder.

The flat of the hand or the fingertips usually best appreciate thrills, which are vibratory sensation that are palpable manifestations of loud, harsh murmurs having low to medium frequency components. Thrills are most readily characterized according to their *timing* in the cardiac cycle (systolic, diastolic, or continuous), their *location*, their direction of *radiation*, and their *duration*. High-pitched murmurs such as those produced by valvular regurgitation even when loud are not usually associated with thrills.

Systolic thrills at the right or left base as in AS or PS can be palpated with the patient supine at 30–45°, or still better with the patient sitting and leaning forward during full held expiration. When the thrill is prominent and

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widespread, application of the entire palm of the hand is sometimes helpful in sensing the direction of radiation of the aortic stenotic thrill upward and to the right, and radiation of the pulmonic stenotic thrill upward and to the left.

Thrills may be felt at the apex in MR and HOCM, lower left sternal border in ventricular septal defect (VSD). It is useful to localize the site of maximum intensity of a left parasternal systolic thrill. Maximum intensity in the second intercostal space occurs in pulmonic valve stenosis, in the third intercostal space in infundibular pulmonic stenosis, and in the fourth or fifth intercostal space with ventricular septal defect (VSD). Two or three fingers can be applied simultaneously in the second, third and fourth or fourth, fifth, and sixth interspaces. Most systolic thrills are better identified during expiration, but the thrill of TR is better sensed or may appear only during inspiration.

An **early diastolic left parasternal thrill** is more likely to accompany aortic regurgitation (AR), less likely the Graham Steel murmur of high-pressure PR, because the latter is usually grade 3 or less. The best technique for eliciting these left parasternal high frequency early diastolic thrills is by applying the distal metacarpals or fingertips at the left sternal edge with the patient first supine at 30–45° and then sitting and leaning forward during full held expiration. When the diastolic thrill of AR is better detected at the right sternal edge, the cause is likely to be a dilated aortic root, as in Marfan syndrome.

Systolic and diastolic **thrills at the apex** are best assessed during held expiration with the patient in a partial left lateral decubitus position. An intense systolic thrill of MR commonly radiates into the axilla, sometimes to the left sternal edge, to the base, and even into the neck.

A diastolic thrill occasionally may be felt at the apex in the lateral decubitus position in MS. Equivocal thrills often become more pronounced when the patient voluntarily coughs briskly, a maneuver that transiently increases the heart rate and mitral flow.

Gently placing a fingertip in the suprasternal notch will allow detection of thrills in patients with aortic valve stenosis, pulmonary valve stenosis, AR, PDA, or coarctation of aorta. In these lesions, a thrill may also be palpable over the carotid arteries.

Stenotic RV-PA conduits may produce a thrill. These are usually felt along the left sternal border.

PALPABLE SOUNDS

Prominent S1 (mitral component): It may be sometimes palpable over the LV impulse in the left lateral decubitus position during held expiration in thin, slightly built subjects, especially if the PR interval is short and cardiac rate rapid. Palpation is best accomplished by relatively firm pressure of a fingertip. In rheumatic mitral stenosis with mobile anterior leaflet, a loud first heart is often more readily palpable than accompanying LV impulse.

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Aortic component (A2): Loud aortic valve closure sounds may be audible. This is often palpable in the second right interspace in the presence of simple systemic hypertension. This is also palpable when the aortic root is dilated and the pulmonary trunk small [as in severe tetralogy of Fallot (TOF) or pulmonary atresia] or when the aortic root is anterior to the pulmonary trunk as in complete transposition of the great arteries.

Pulmonary component (P2): The pulmonic component of the second heart sound is palpated in the second left interspace in patients with PAH, although dilatation of the pulmonary trunk with normal pulmonary arterial pressure occasionally renders the pulmonic component palpable. In some normal children and adolescents and in thin subjects with decreased AP chest dimensions, a normal pulmonic component of the second heart sound is occasionally palpated as a gentle tap. Palpation is enhanced when a fingertip is applied between the ribs in the second LICS with moderate pressure during held expiration. Pressure at the same site with the distal metacarpal is also useful. A very loud pulmonic component transmits widely to the mid and lower left sternal edge, right base, and apex, especially when the RV occupies the apex.

Aortic ejection sounds: In congenital aortic stenosis (AS), it may be more readily palpated over the LV impulse than in the second right interspace, and therefore, must be distinguished from a loud first heart sound. A normal PR interval and a relatively slow heart rate assist in this distinction. Aortic ejection sounds that originate within a dilated aortic root (in contrast to origin in the valve itself) are better palpated at the right base over the site of systolic movement of the dilated aorta. Palpation is accomplished at this site by moderately firm pressure of a fingertip applied during held expiration or by firmly applying the distal metacarpals.

Pulmonary ejection sound: This may be palpable in the second LICS and are sometimes sensed only during normal expiration, diminishing or vanishing altogether during normal inspiration.

Presystolic pulsation: It is best palpated during exhalation, when the patient is in left lateral decubitus position with light pressure of fingertips over the apex. It can be confirmed by observing the motion of an X mark over the LV impulse. It can be enhanced by sustained handgrip. Audibility of the S4 does not correlate with palpability; presystolic expansion may be detectable when the S4 is quite soft. Occasionally one may not hear an S4, when it is clearly palpable, because of the extremely low frequency vibrations of the diastolic filling event, usually <50 cycles per second.

Diastolic heartbeat: The precordial diastolic movement in chronic constrictive pericarditis has been called the "diastolic heartbeat".

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This movement coincides with rapid diastolic flow into the constricted ventricles (left and right) and is synchronous with the brisk Y trough of JVP.

Opening snap: The most common early diastolic sound amenable to palpation because of intensity per se is the opening snap of mitral stenosis. The sound is palpable over the LV impulse, but when loud, radiates to the lower left sternal edge.

Tumor plop: A relatively rare palpable early diastolic sound—the "tumor plop"—is generated during abrupt deceleration of a mobile, pedunculated right or left atrial myxoma as the tumor seats within the tricuspid or mitral orifice.

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