

## Precordial and Carotid Pulse Palpation

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**P**recordial and carotid pulse palpation is an important feature of the physical examination of the cardiovascular system. Evaluating precordial impulses for contour, duration, and amplitude can help in estimating the size of cardiac chambers and identifying valvular abnormalities (Table 1); the contour, duration, and amplitude of the carotid pulse can also provide important information pertaining to underlying cardiac abnormalities (Table 2). This article reviews precordial impulses and the carotid pulse and discusses ways in which abnormal findings during the examination of these aspects of the cardiovascular system may be interpreted.

### PRECORDIAL PALPATION

#### Technique

The movements and general physical appearance of the chest wall should be evaluated before palpation. Some chest movements are better observed than felt.<sup>1</sup> Shining a light across the chest wall can help to accentuate some cardiac impulses. When palpating the precordium, the examiner should stand at the patient's right; the patient should be in a supine position. It is best to use the palmar surface of the right hand and palpate in the following sequence: apex, left parasternal region, sternum, right parasternal region, and cardiac base.

#### Left Ventricular Impulse

Traditionally, the term *apical impulse* refers to the left ventricular impulse; sometimes this impulse is referred to as the *point of maximal impulse*. It occurs at the onset of left ventricular ejection and is normally located within the left midclavicular line in the fifth intercostal space (Figures 1 and 2A).

A left ventricular impulse that is normal in location but sustained (ie, "heaving") in duration typically occurs in conditions of increased pressure load (eg, aortic stenosis, systemic hypertension) (Figure 2B). A laterally displaced left ventricular impulse that has increased amplitude (or that is hyperkinetic) and

### PRECORDIAL AND CAROTID PULSE PALPATION

**Precordial palpation:** Can aid in estimating the size of cardiac chambers and in identifying valvular abnormalities

**Carotid pulse palpation:** Can aid in identifying cardiac disease

increased area typically occurs in conditions of increased volume load (eg, aortic and mitral regurgitation).<sup>2</sup>

A prominent, palpable presystolic left ventricular impulse usually represents forceful contraction of the left atrium against elevated left ventricular end-diastolic pressure and coincides with an audible S<sub>4</sub>.<sup>3</sup> As a rule, a loud S<sub>4</sub> is accompanied by a palpable presystolic impulse (Figures 2B and 2C). A hyperkinetic trifid left ventricular impulse is sometimes observed with hypertrophic cardiomyopathy and represents 1 presystolic and 2 systolic waves (Figure 2C). Also, in hypertrophic cardiomyopathy, the left ventricular impulse is shifted slightly downward and to the left of its normal anatomic position.

#### Right Ventricular Impulse

Traditionally, the term *left parasternal impulse* refers to the right ventricular impulse—the right ventricle lies under the anterior precordium adjacent to the lower left sternal edge. A palpable right ventricular impulse along the lower left sternal edge is referred to as a *right*

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**Table 1.** Clinical Correlations of Abnormal Precordial Impulses

Impulse	General Clinical Correlation	Specific Conditions
Sustained left ventricular impulse	Increased pressure load	Aortic stenosis, systemic hypertension, dilated cardiomyopathy
Enlarged (hyperkinetic) left ventricular impulse	Increased volume load	Aortic and mitral regurgitation, hypertrophic cardiomyopathy, dilated cardiomyopathy
Displaced left ventricular impulse (downward and to the left of normal position)	Increased volume load	Aortic and mitral regurgitation, dilated cardiomyopathy, hypertrophic cardiomyopathy
Presystolic left ventricular impulse	Increased pressure load	Aortic stenosis, systemic hypertension
Bifid left ventricular impulse	Obstruction occurring midway in systole as the mitral valve approximates a hypertrophied septum	Hypertrophic cardiomyopathy*
Right ventricular heave or lift	Anterior displacement of right ventricle Right ventricular dilation	Mitral regurgitation Mitral stenosis, pulmonary hypertension
Thrills	Associated with murmurs	Aortic stenosis, pulmonic stenosis, ventricular septal defect, severe mitral regurgitation, patent ductus arteriosus

\*Sometimes a trifid left ventricular impulse occurs with hypertrophic cardiomyopathy, as a result of a forceful presystolic impulse correlating with an S<sub>4</sub>.

*ventricular heave* or *lift* and is usually a clinical sign of right ventricular hypertrophy<sup>4</sup>; however, conditions such as mitral regurgitation can anteriorly displace the right ventricle and cause a right ventricular heave as well. Volume overloading of the right ventricle exaggerates the amplitude of the right ventricular impulse, whereas pressure overloading exaggerates the duration of the impulse.

### Thrills

Thrills, defined as palpable vibrations, are felt best with the distal palm or ball of the hand pressed firmly against the precordium. Thrills may accompany murmurs, such as those associated with aortic stenosis, patent ductus arteriosus, and ventricular septal defect. The detection of thrills can help in differentiating grade 3 from grade 4 murmurs; that is, murmurs of grade 4 loudness or greater are palpable as a thrill.

### CAROTID PULSE PALPATION

A tracing of the normal carotid pulse involves a smooth, rapid upstroke with a dome-shaped peak (Figure 3A). The normal carotid pulse begins 40 to 80 msec after S<sub>1</sub>.<sup>5</sup> A hyperkinetic pulse is described as a rapidly rising pulse of increased amplitude. A classic example of a hyperkinetic pulse occurs in aortic regurgitation as a result of widened pulse pressure (Figure 3B). Other conditions of high cardiac output (eg, anemia, thyrotoxicosis) can also cause a hyperkinetic pulse.

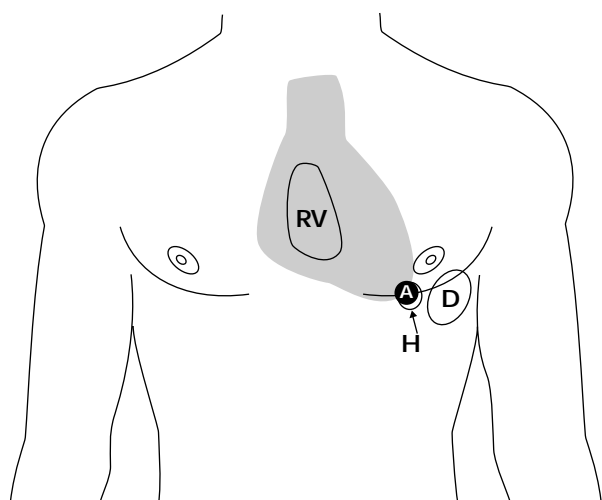
A hypokinetic pulse, which is of low amplitude, occurs as a result of a reduction in left ventricular stroke volume or a decrease in systemic arterial pressure. A hypokinetic carotid pulse is sometimes called *pulsus parvus*; a pulse that is slow in rising and late in peaking is called *pulsus tardus*. Pulsus parvus typically occurs in conditions of diminished left ventricular stroke volume (eg, congestive heart failure), whereas pulsus tardus typically occurs in conditions of aortic outflow obstruction (eg, aortic stenosis). A carotid pulse having characteristics of both types of pulses is termed *pulsus parvus et tardus* (Figure 3C).

Pulsus bisferiens (or a bisferious pulse) is characterized by a double impulse during systole, owing to a midsystolic dip (Figure 3D). Major disorders associated with pulsus bisferiens include aortic regurgitation, combined aortic stenosis and regurgitation, and hypertrophic cardiomyopathy. The midsystolic dip is caused by different mechanisms in different conditions. For example, in aortic stenosis and aortic regurgitation, the midsystolic dip is generated by a decrease in the lateral wall pressure of the ascending aorta, whereas in hypertrophic cardiomyopathy, obstruction occurs midway in systole as the mitral valve approximates the hypertrophied septum.

Pulsus paradoxus occurs when there is a significant palpatory decrease in the strength of the carotid pulse during normal inspiration. Pulsus paradoxus is observed

**Table 2.** Clinical Correlations of Abnormal Carotid Pulses

Pulse	General Clinical Correlation	Specific Conditions
Hyperkinetic pulse	Wide pulse pressure	Aortic regurgitation, anemia, thyrotoxicosis
Hypokinetic pulse	Low cardiac output, low arterial pressure	Dilated cardiomyopathy, mitral stenosis, recent myocardial infarction
Pulsus bisferiens	Left ventricular outflow obstruction	Aortic regurgitation, hypertrophic cardiomyopathy
Pulsus parvus et tardus	Aortic outflow obstruction	Aortic stenosis
Pulsus paradoxus	Palpatory decrease in strength of arterial pulse during normal inspiration	Pericardial tamponade, restrictive pericarditis, vena caval obstruction
Pulsus alternans	Severe left ventricular failure	Dilated cardiomyopathy



**Figure 1.** Normal and abnormal locations of precordial impulses. A = normal location of the left ventricular impulse in the left midclavicular line in the fifth intercostal space (approximately 1.5 cm in diameter); D = location of left ventricular impulse in dilated cardiomyopathy (in comparison with normal location, substantially larger in size and shifted inferiorly and to the left); H = location of left ventricular impulse in cardiac hypertrophy (in comparison with normal location, may be slightly shifted inferiorly and to the left and may be approximately 2.5 cm in diameter); RV = normal location of the right ventricular impulse along the lower left sternal border (rarely, an enlarged left atrium may produce an impulse in the superior part of this area).

in conditions restricting the inspiratory increase in blood flow to the right ventricle (eg, pericardial tamponade, restrictive pericarditis, vena caval obstruction). A blood pressure cuff can also be used to detect a drop in systolic pressure of more than 10 mm Hg during inspiration.

Pulsus alternans occurs when there is an alternation in the pulse amplitude from beat to beat when the

rhythm is regular. This pattern is usually a sign of severe left ventricular dysfunction. The alternating amplitude becomes more obvious as the pulse wave moves peripherally. Therefore, use of the radial or femoral arteries is best for detecting pulsus alternans.

## CLINICAL CORRELATIONS

### Aortic Stenosis

Palpation of the precordium in the setting of aortic stenosis reveals a sustained forceful left ventricular impulse, a prominent presystolic impulse, and a systolic thrill over the second right intercostal space. An  $S_4$  is usually audible if the obstruction is significant. Palpation of the carotid arteries reveals a diminished and slowly rising carotid pulse (ie, a pulsus parvus et tardus) (Figure 3C).

### Aortic Regurgitation

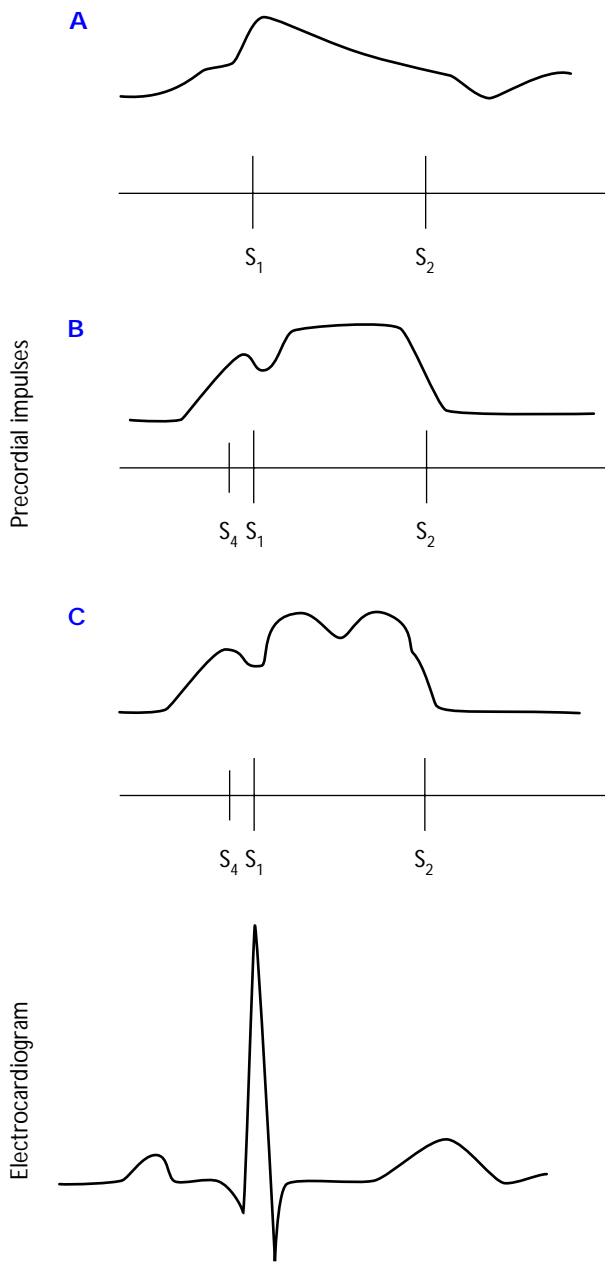
Palpation of the precordium in the setting of aortic regurgitation reveals a hyperkinetic left ventricular impulse that is shifted downward and to the left; palpation of the carotid arteries reveals a rapidly rising and collapsing pulse, otherwise known as a *bounding pulse*; other names given to the pulse in aortic regurgitation include *Corrigan pulse* and *water-hammer pulse*.<sup>6</sup> The pulse is usually bisferious as well.

### Mitral Stenosis

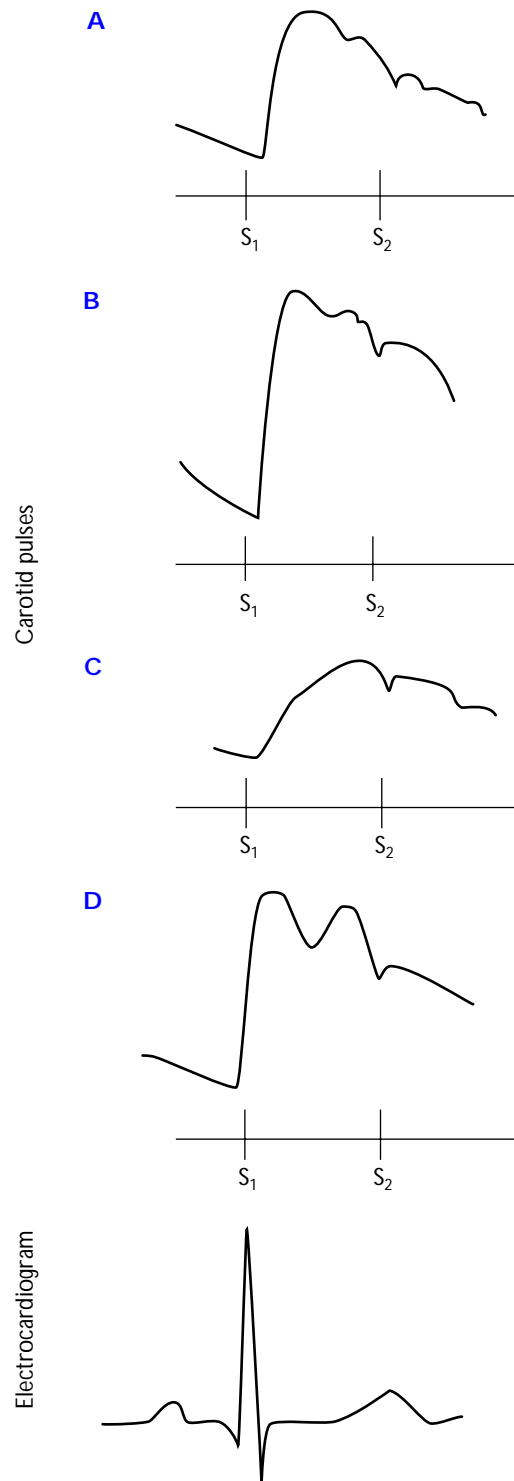
Palpation of the precordium in the setting of mitral stenosis reveals a right ventricular heave at the lower left sternal border as a result of anterior displacement of the right ventricle. The left ventricular impulse is very small or impalpable. Also present is a middiastolic or presystolic thrill at the apex. The carotid pulse is diminished or hypokinetic.

### Mitral Regurgitation

Palpation of the precordium in the setting of mitral



**Figure 2.** Schematic representation of the simultaneous recording of an electrocardiogram and normal and abnormal left ventricular impulses. (A) Normal left ventricular impulse. (B) Sustained left ventricular impulse with a palpable presystolic impulse coinciding with an  $S_4$ . (C) Hyperkinetic trifid left ventricular impulse with a palpable presystolic impulse coinciding with an  $S_4$ .



**Figure 3.** Schematic representation of the simultaneous recording of an electrocardiogram and normal and abnormal carotid pulses. (A) Normal pulse. (B) Hyperkinetic pulse. (C) Pulsus parvus et tardus. (D) Pulsus bisferiens.

regurgitation reveals a hyperkinetic left ventricular impulse that is shifted to the left. When the regurgitation is severe, the left ventricular impulse is sustained and large. A right ventricular heave may also be present if pulmonary hypertension has developed. The carotid pulse is slightly diminished in amplitude because of a decrease in left ventricular ejection.

#### **Hypertrophic Cardiomyopathy**

Palpation of the precordium in the setting of hypertrophic cardiomyopathy reveals a displacement of the left ventricular impulse downward and to the left of its normal position. Palpation usually reveals a bifid left ventricular impulse as well. Sometimes a trifid left ventricular impulse is palpable as a result of a forceful presystolic impulse correlating with an  $S_4$ . The carotid pulse is bisferious during systole.

#### **Dilated Cardiomyopathy**

Palpation of the precordium in the setting of dilated cardiomyopathy also reveals a displacement of the left ventricular impulse downward and to the left of its normal position. The left ventricular impulse is also enlarged and sustained. Pulsus alternans is noted on palpation of the carotid pulse but is most marked in the peripheral pulses (ie, the pulses of the radial and femoral arteries).

#### **CONCLUSION**

A physical examination is an inexpensive method of assessing the cardiovascular system that can provide important information pertaining to underlying cardiac disease. A complete cardiac examination includes precordial and carotid pulse palpation. Although there is declining interest in the art of cardiovascular palpation, owing to the advancement of noninvasive imaging techniques,<sup>7</sup> palpation may prove valuable during an overall patient evaluation. **HP**

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