

Comprehensive Guide to Arterial Pulse Examination: Techniques, Physiology, and Clinical Significance

Arterial Pulse Examination: Comprehensive Clinical Summary

Overview

Arterial pulse examination is a fundamental clinical skill that provides critical insights into cardiovascular function and hemodynamic status. Despite advances in imaging, it remains essential for diagnosis and clinical assessments. The pulse is a

pressure wave

generated by left ventricular ejection during systole, traveling faster (~ 10 m/sec) than blood flow (~ 0.3 - 0.5 m/sec), and serves as a direct index of cardiac performance.

Technique and Peripheral Pulses

Examination should be systematic and bilateral to detect asymmetry (e.g., coarctation, aortic dissection). Key arteries include:

- **Radial:** Most common site for rate and rhythm.
- **Carotid:** Best for assessing character and volume; located in the carotid triangle.
- **Femoral:** Midpoint between ASIS and pubic symphysis.
- **Dorsalis pedis:** Proximal first web space; absent in $\sim 10\%$ of healthy individuals.
- **Posterior tibial, popliteal, brachial, axillary, subclavian, superficial temporal**
: Each with specific landmarks.

Palpation technique

: Use three fingers (index, middle, ring), apply gentle pressure to avoid feeling the examiner's pulse. Patient positioning enhances detection.

Physiology of Pulse Waveform

The arterial pulse reflects changes in **wall tension** (Laplace's Law). Components:

- **Systole**
: Percussion wave (initial peak), tidal wave (stroke volume), anacrotic notch (between waves).
- **Diastole:** Incisura (aortic valve closure, S2), dicrotic wave (reflected wave).

With peripheral travel:

- Upstroke steepens.
- Anacrotic notch diminishes.

- Tidal and dicrotic waves merge.

Components of Pulse Assessment

Evaluate the following:

Rate

- **Normal:** 60-100 bpm.
- **Tachycardia** (>100): Exercise, fever, anemia, hyperthyroidism, MI, atrial fibrillation.
- **Bradycardia** (<60): Athletes, sleep, inferior MI, beta-blockers, hypothyroidism.
- Rate increases ~10 bpm per 1°C temperature rise.

Rhythm

- **Regularly irregular:** Sinus arrhythmia, premature beats, fixed AV block.
- **Irregularly irregular:** Atrial fibrillation (delirium cordis).
- **Respiratory sinus arrhythmia**
: Normal in youth; HR increases with inspiration, decreases with expiration due to vagal tone changes.

Volume and Pulse Pressure

- **Pulse pressure = SBP - DBP;** normal: 30-60 mmHg.
- **Low pulse pressure** (<30 mmHg): Thready pulse; seen in **shock, hypovolemia, heart failure.**
- **High pulse pressure** (>60 mmHg): Bounding pulse; seen in **aortic regurgitation, anemia, pregnancy, thyrotoxicosis, PDA, AV fistula.**

Character (Contour)

- **Pulsus parvus et tardus:** Small, slow-rising; **aortic stenosis.**
- **Water hammer (Corrigan's) pulse:** Rapid rise and fall; **aortic regurgitation, PDA, thyrotoxicosis.**
- **Pulsus bisferiens:** Two systolic peaks; seen in **severe AR, AR+AS, HOCM.**
- **Pulsus alternans:** Alternating strong/weak pulses; **severe LV dysfunction.**
- **Pulsus bigeminus:** Normal beat → premature beat → pause; due to **VPCs**, often from **digoxin toxicity.**
- **Anacrotic pulse:** Slow rise with palpable notch; **severe AS with preserved output.**
- **Dicrotic pulse:** Systolic and diastolic peaks; seen in **shock, tamponade, severe LV failure.**

Delay

- **Radio-femoral delay:** Suggests **coarctation of aorta, Takayasu arteritis.**
- **Radio-radial delay:** Indicates **subclavian stenosis, aortic dissection.**

Tension (Palpatory Tone)

- Correlates with diastolic BP: pulsus durus (firm), pulsus mollis (soft).

Paradoxus

- **Pulsus paradoxus:** >10 mmHg systolic drop during inspiration; causes: **cardiac tamponade, constrictive pericarditis, severe asthma/COPD.**

- **Reverse pulsus paradoxus:** Systolic rise during mechanical inspiration; seen in **mechanical ventilation, HOCM, A-V dyssynchrony**.

Vessel Wall Condition

- **"Pipe-stem" rigidity:** Suggests atherosclerosis or arteriosclerosis.
- Radial artery resists atherosclerosis but stiffens with age.

Key Differentiators

- **Pulse deficit** (apical rate - radial pulse): >10 bpm suggests **atrial fibrillation**; absent in AV block.
- **Post-extrasystolic pulse:** Present in **VPCs** (bounding due to compensatory pause), absent in **AF**.
- **JVP A wave:** Absent in AF, present in VPCs.

Special Signs and Clinical Pearls

- **Hill's sign:** Femoral SBP $\geq$ 20 mmHg > radial SBP in **severe aortic regurgitation** ; due to wave amplification in elastic arteries.
- **Auscultatory gap:** Transient disappearance of Korotkoff sounds; may cause **underestimation of BP** . Prevent by palpating radial pulse while inflating cuff.
- **Apex-carotid delay:** Palpable lag in carotid upstroke; diagnostic of **aortic stenosis**.
- **Carotid thrill:** Palpable vibration; associated with **severe AS**.

Conditions and Associated Pulse Patterns

Condition	Pulse Pattern	Key Features
Aortic stenosis	Pulsus parvus et tardus / anacrotic	Small, slow-rising, delayed peak
Aortic regurgitation	Water hammer, bisferiens	Rapid rise/fall, high pulse pressure
HOCM	Bisferiens-like	Mid-systolic dip due to SAM
Severe LV failure	Pulsus alternans, dicrotic	Alternating amplitude, diastolic peak
Atrial fibrillation	Irregularly irregular + pulse deficit	>10 bpm deficit diagnostic
VPCs / bigeminy	Pulsus bigeminus	Premature beat + compensatory pause

Mechanisms of High-Output States

Conditions causing **hyperkinetic (bounding) pulse**:

- **Aortic regurgitation:** Diastolic runoff → volume overload → ↑ stroke volume.
- **Mitral regurgitation, VSD:** Left-sided volume overload.
- **PDA, AV fistula:** Shunts causing increased return.

- **Non-cardiac**

: Anemia, thyrotoxicosis, beriberi, pregnancy - all reduce SVR or increase CO via sympathetic activation.

Age-Related Changes

- **Young:** Compliant vessels → reflected wave in diastole → normal aortic notch.

- **Elderly**

: Stiff arteries → reflected wave in late systole → elevated central SBP, prominent tidal/aortic waves.

Conclusion

Pulse examination integrates physiology and pathology, offering powerful diagnostic clues. Mastery of

rate, rhythm, volume, contour, delay, tension, and paradoxus

is vital for clinical competence. Despite modern tools, it remains a cornerstone of cardiovascular assessment, especially in detecting conditions like

aortic stenosis, regurgitation, HOCM, tamponade, coarctation, and arrhythmias.

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