



IVUS terminology

Acoustic shadowing: An artifact representing weakness or absence of signals located beyond structures (e.g., calcium, stent struts) with high echo-reflectivity. This artifact can hinder imaging beyond strong reflectors.

Adventitia: The outer layer of an artery, usually echo dense (echogenic), composed of collagen and elastic fibers.

Amplitude: Strength of an ultrasound wave measured in decibels.

Aperture: The active part of the transducer that emits and/or receives ultrasound waves. Resolution and near field size can be directly related to the aperture; with increasing aperture size, the near field can be longer, thereby improving the axial resolution.

Artifact: Anything displayed that is not properly indicative of the structure(s) being imaged; includes distortions of the image and “phantom” echoes due to imaging system errors.

Attenuation: Reduction of ultrasound wave intensity or amplitude as it passes through tissue; measured in decibels.

Average reference lumen size: The average value of lumen size at the proximal and distal reference sites.

Axial resolution: Ability to resolve two closely positioned points along the axis of the sound wave. These points are on a line that begins at the center of the image and are not equal in distance from the transducer.

Backscatter: Ultrasound “scattered” back in the direction from which it originally came; ultrasound which is reflected back to the transducer rather than absorbed or passing through tissue.

Bandwidth: A range of consecutive frequencies including the operating frequency produced by the transducer. Higher bandwidths generally translate to higher fidelity images.

Barotrauma: Injury to vessel/intima due to pressure from over inflation of balloon or stent.

Binding: Inability of the imaging transducer to rotate freely. Seen on an image as a distorted or smeared sector(s) in an ultrasound image. Commonly known as NURD (non-uniform rotational distortion).

Blood speckle: The ultrasound reflection from aggregated blood cells. The appearance of blood in the lumen of the vessel as seen in an ultrasound image. This effect increases with higher frequency systems.

Calcific plaque: Atherosclerotic substance hardened by the deposition of calcium in the tissue. Calcific plaque is highly echo-reflective (white) and often produces acoustic shadowing behind it. The arc of calcium can be measured in degrees.

ChromaFlo imaging: An option that provides a visual depiction of blood flow through the vessel by overlaying a two dimensional color mapping of relative blood flow velocity onto the grayscale IVUS image.

Concentric plaque: Plaque is distributed along the entire circumference.

Compress: A control that regulates the dynamic compression and affects grayscale and overall gain. In general, the higher the compression setting, the more black and white the image will appear. An imaging control which defines the dynamic range.

Cross sectional area (CSA): Calculated area of a vessel or lumen measured in mm².

Decibel: A unit used to classify the intensity of a sound. Higher numbers mean more intense (louder) sounds. Logarithmic scales are used; abbreviated dB.

Deep calcium: The leading edge of the acoustic shadowing appears within the deepest 50% of the plaque plus media thickness.

Diffraction: The bending of waves around edges.

Distal reference: The site with the largest lumen distal to a stenosis but within the same segment (usually within 10 mm of the stenosis with no intervening branches). This may not be the site with the least plaque.

Divergence: Plaque normally forms on the opposite side of vessel from branch bifurcation in epicardial vessels (except septals).

Dynamic range: The range of grayscale that is displayed between the weakest and the strongest targets. It is usually expressed in decibels (dB). A large or broad dynamic range is a favorable image characteristic. The dynamic range for IVUS is typically 17 to 55 dB.

Eccentric plaque: Plaque having an arc of normal arterial wall within the lesion.

Echogenic: Echodense or hyperechoic: high echo reflectivity.

Echogenicity: The tendency of a tissue to reflect ultrasound. The higher the echogenicity, the brighter the tissue will appear.

Echolucent: Structures that permit high-frequency sound waves to pass through and thus give off few echoes. Appears dark or black on display screen. Also called hypoechoic.

Encrustation: Includes lesion layer where many unstable lesions show evidence of multiple prior events with stepwise plaque growth.

Erosive plaque: Plaque having the property of eroding or wearing away.

External elastic membrane (EEM CSA) or lamina: External elastic membrane cross-sectional area, also called vessel CSA, is the area inside of adventitia measured at the site of external elastic membrane (outer boundary of media).

Far field: The region where the ultrasound beam diverges and resolution decreases.

Fibrocalcific: Fibrotic tissue.

Fibrous: Soft tissue.

Fibrous plaques: These plaques have an intermediate echogenicity between soft (echolucent) atheroma and highly echogenic calcific plaques.

Frame: A single image composed of multiple scan lines; the displayed image produced by one complete 360 degree scan of the sound beam.

Frame rate: The number of frames or complete scans the system is capable of displaying per second.

Frequency: Number of cycles per second. For IVUS, this represents the number of times a sound wave is generated per second by the transducer.

Gain: Ratio of output power to input power of signal intensity; this control increases or decreases the received echo strength; similar to adjusting the volume of sound on a radio.

Grayscale: The ability of a system to record both bright and weak echoes in varying shades of gray; brightness is proportional to the intensity amplitude) of the returning echo. The number of grayscale levels is a measure of the dynamic range.

Hertz: Standard unit of frequency; one cycle per second.

Hyperechoic: A structure or tissue which is highly reflective (readily produces echoes) such as calcific plaque. Appears bright (or white) on the display. Also called echogenic.

Hypoechoic: A region of low reflectivity (limited echo production). Appears dark (or black) on the display. Also called Echolucent.

Intensity: Power divided by area. The amount of sonic energy per unit area; represents the strength of the ultrasound beam; measured in dBs.

Integrated backscatter: Power (amplitude) measurements of the received backscatter signal.

Intima: The "inner layer" of the artery, often unseen due to thin non-echogenic cell layer, composed of fragile endothelial; thickness is approximately 100 microns.

Intimal hyperplasia: A physiologic healing response to injury to the blood vessel wall. The intimal hyperplasia characteristic of early in-stent restenosis often appears as tissue with very low echogenicity, at times less echogenic than the blood speckle in the lumen.

Intracardiac imaging: Examination of cardiac structures, such as the heart wall using an imaging catheter positioned at the point of interest.

Intraluminal imaging: Examination of a hollow structure in the body using an appropriately sized imaging catheter at the point of interest; includes both vascular and non-vascular structures.

Intravascular: Examination from within a vascular structure.

Intravascular imaging catheter: A catheter with an imaging transducer; used in intravascular or intracardiac imaging applications. Two types are available; mechanical and all-digital.

Involution: Appearance of medial layer thickening in the presence of intimal plaque due to attenuation of signal. Media is actually thinner in this case.

Largest reference: The largest of either the proximal or distal reference sites.

Lesion: A lesion represents accumulation of atherosclerotic plaque compared with a predefined reference.

Lumen area stenosis: Reference lumen CSA minus minimum lumen CSA divided by reference lumen CSA. $(RLA - MLA)/RLA$. The reference segment used should be specified (proximal, distal, largest or average).

Lumen lumen cross-sectional area (CSA): The area bounded by the luminal border.

Maximum lumen diameter: The longest diameter through the center point of the lumen.

Maximum stent diameter: The longest diameter through the center of mass of the stent.

Minimal lumen area (MLA): Smallest lumen CSA within lesion segment

Minimum lumen diameter: The shortest diameter through the center point of the lumen.

Minimum stent diameter: The shortest diameter through the center of mass of the stent.

Mixed plaque: Plaques frequently contain more than one acoustical subtype. Appropriate terminology for these plaques includes a number of descriptions such as "fibrocalcific" and "fibrofatty."

Near Field: The zone where the beam width is approximately the same as the transducer diameter, resulting in optimal resolution.

Non-uniform rotational distortion (NURD): Inability of the rotational imaging transducer to rotate freely due to friction. Seen on an image as a distorted or smeared sector(s) in an ultrasound image.

Plaque plus media (or atheroma) CSA: The EEM CSA minus the lumen CSA. $(EEM\ CSA - lumen\ CSA)$.

Plaque burden: Plaque plus media or atheroma area divided by the EEM CSA $(EEM\ CSA - lumen\ CSA)/EEM\ CSA$. The atheroma burden is distinct from the luminal area stenosis. The former represents the area within the EEM occupied by atheroma regardless of lumen compromise. The latter is a measure of luminal compromise relative to a reference lumen analogous to the angiographic diameter stenosis. Percent plaque burden is plaque burden times 100.

Proximal reference: The site with the largest lumen proximal to a stenosis but within the same segment (usually within 10 mm of the stenosis with no major intervening branches). This may not be the site with the least plaque.

Plaque rupture: Plaque ulceration with a tear detected in a fibrous cap. Contrast injections may be used to prove and define the communication point.

Plaque ulceration: A recess in the plaque beginning at the luminal-intimal border, typically without enlargement of the EEM compared with the reference segment.

Pseudoaneurysm: Disruption of the EEM, usually observed after intervention.

Radiofrequency: Data after being converted from ultrasound to electrical signals, but before being processed, are in the RF range of electromechanical energy. Analysis of RF signals may give rise to tissue characterization in IVUS.

Rejection: A means of eliminating noise from the image by filtering low-amplitude signals.

Resolution: The ability to discriminate or identify two objects that are close together.

Reverberations: An artifact represented by secondary, false echoes of the same structure. This gives the false impression of a second interface twice as far from the transducer as the first structure.

Ring down: Reverberations of transmitted pulses of sound caused by the small amplitude (low intensity) waves that occur as each pulse fades out. The artifact due to ring down typically appears as a "halo" effect around the catheter and can, occasionally, look like concentric rings surrounding the catheter.

Rouleaux: A swirling appearance of blood flow commonly visualized distal to lesion. Secondary stenosis (T-2, T-3, etc.): Lesions meeting the definition of a stenosis, but with lumen sizes larger than the worst stenosis.

Side lobes: Extraneous beams of ultrasound that are generated from the edges of the individual transducer elements and are not in the direction of the main ultrasonic beam.

Soft plaques: The term "soft" refers not to the plaque's structural characteristics, but rather to the acoustic signal that arises from low echogenicity. This is generally the result of high lipid content in a mostly cellular lesion.

Sound: A mechanical wave or series of compressions and expansions that move particles in a direction parallel to that of the traveling wave.

Spontaneous coronary acute dissection (SCAD): A tear within the vessel.

Stenosis: A stenosis is a lesion that compromises the lumen by at least 50% by cross-sectional area (CSA) compared with a predefined reference segment lumen.

Stent CSA: The area bounded by the stent border.

Stent expansion: The minimum stent CSA compared with the predefined reference area, which can be the proximal, distal, largest, or average reference area.

Stent malapposition: Also known as incomplete stent apposition. The absence of contact between the stent struts and vessel wall no overlapping a side branch.

Stent sizing for remodeled vessels: Mid-wall calculation; use average of distal reference lumen and vessel diameters; (vessel diameter + lumen diameter) / 2 = approximate stent size.

Stent symmetry: Maximum stent diameter minus minimum stent diameter divided by maximum stent diameter. (Max stent diameter - Min stent diameter) / max stent diameter.

Superficial calcium: The leading edge of the acoustic shadowing appears within the shallowest 50% of the plaque plus media thickness.

Thin-cap fibroatheroma (TCFA): Most often a precursor to vulnerable plaques and characterized by a necrotic core with an overlying fibrous cap measuring <65 µm, containing rare smooth muscle cells but numerous macrophages.

Thrombus: A thrombus is usually recognized as an intraluminal mass, often with a layered, lobulated, or pedunculated appearance. The ultrasound image is similar to soft plaque, but may not be mobile, scintillating or specular.

Time gain compensation: Amplifies the intensity of signals returning from specific depths to compensate for the attenuation (loss) of the ultrasound beam as it passes through the tissue. Allows the operator to selectively increase the sensitivity of the imaging system at specific depths which improves the image clarity provided (TGC).

Tissue characterization: An approach that uses ultrasound to identify the physiologic and/or pathologic composition of biological tissue.

Transducer: A device capable of converting one form of energy to another. For ultrasound applications, the catheters probe contains a crystal which converts electrical energy into ultrasound and then back again.

True aneurysm: A lesion that includes all layers of the vessel wall with an EEM and lumen area >50% larger than the proximal reference segment.

Ultrasound: Sound waves having a frequency $\geq 20,000$ cycles per second (i.e., above the audible range). For medical diagnostic purposes, ultrasound frequencies in the range of millions of cycles per second (MHz) are used.

Velocity: The velocity at which sound travels through human soft tissue; this is fairly constant at approximately 1,540 m/s.

VH IVUS imaging*: A technology that uses advanced, proprietary spectral analysis techniques to classify plaque into 4 tissue types with 93-97% accuracy. Those plaque types are fibrous, fibro-fatty, necrotic core and dense calcium.

Worst stenosis (T-1): The stenosis with the smallest lumen size.

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*Safety and effectiveness of VH IVUS for use in the characterization of vascular lesions and tissue types has not been established. For further information about Philips and its products, please visit www.philips.com.

