

Guidelines

Standardized medical terminology for cardiac computed tomography: A report of the Society of Cardiovascular Computed Tomography

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Abstract. Since the emergence of cardiac computed tomography (CT) at the turn of the 21st century, there has been an exponential growth in research and clinical development of the technique, with contributions from investigators and clinicians from varied backgrounds: physics and engineering, informatics, cardiology, and radiology. However, terminology for the field is not unified. As a consequence, there are multiple abbreviations for some terms, multiple terms for some concepts, and some concepts that lack clear definitions and/or usage. In an effort to aid the work of all those who seek to contribute to the literature, clinical practice, and investigation of the field, the Society of Cardiovascular Computed Tomography sets forth a standard set of medical terms commonly used in clinical and investigative practice of cardiac CT.

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Conflict of interest: See Appendix A.

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Introduction

Since the emergence of cardiac computed tomography (CT) at the turn of the 21st century, there has been an exponential growth in research and clinical development of the technique, with contributions from investigators and clinicians from varied backgrounds: physics and engineering, informatics, cardiology, and radiology. However, terminology for the field is not unified. As a consequence, there are multiple abbreviations for some terms, multiple terms for some concepts, and some concepts that lack clear definitions and/or usage. In an effort to aid the work of all those who seek to contribute to the literature, clinical practice, and investigation of the field, this writing group sought to delineate a nomenclature of terms commonly used in clinical and investigative cardiac CT.

The writing group focused on terms most relevant to cardiac CT. Not included within the scope of this document were more general terms related to vascular interpretation and analysis such as *cross-sectional area* or *percent diameter stenosis*. These were thought to be well understood or have been clearly defined in the literature of their respective fields. The one set of exceptions was terms used to describe plaque composition.

Finally, terms that were considered interchangeable without adverse effect (eg, *filter* vs *kernel*), terms about

which there is clearly no ambiguity or need for clarification, and many well-established terms from general radiology (eg, axial, coronal, sagittal) were not considered for this document.

The document underwent external peer review and organization review by the SCCT Board of Directors. Disclosures of potential conflicts of interest for the writing group and external peer reviewers may be found in [Appendix A](#). Affiliations of the external peer reviewers may be found in [Appendix B](#).

Explanation of tables

This document provides tables of standardized medical terminology for cardiac CT applying to *General Equipment and Examination Procedures* (Table 1), *Contrast Injection and Data Acquisition* (Table 2), *Image Reconstruction, Processing, and Analysis* (Table 3), and *Image Interpretation, Analysis, Artifacts, and Radiation* (Table 4). In each table, the recommended terms are listed in the first column, with any recommended abbreviations in parentheses. Definitions and any comments regarding the terms or their usage, including occasional cases of other acceptable terms, are listed in the next column. Previous terms and abbreviations that are not recommended and are to be avoided are in the third column.

Table 1 General equipment and examination procedures

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Electron beam CT (EBCT)	General description of computed tomography systems that generate x-rays by striking a stationary target surrounding the patient with an electronically deflected electron beam	Electron beam tomography, EBT, Ultrafast CT, UFCT
Multidetector row CT (MDCT)	General description of computed tomography systems that generate x-rays with an x-ray tube and detect them with a 2-dimensional array of detectors	Multislice CT, MSCT, multidetector CT
Detector row	Row of detectors in a 2-dimensional array oriented perpendicular to the z-axis (direction of patient movement)	
n-row CT	Specific description of an MDCT scanner based on the number (n) of detector rows	
Slice	A portion of the image volume specifically oriented perpendicular to the z-axis	
n-slice CT	Specific description of an MDCT scanner based on the maximum number (n) of simultaneously acquired slices	
n-row CT	Specific description of an MDCT scanner based on the number of detector rows used to simultaneously acquire CT attenuation data	
Cardiac computed tomography (Cardiac CT)	Computed tomographic imaging of the heart using ECG-gating or ECG-triggering; may be specified as "noncontrast cardiac CT" or "contrast-enhanced cardiac CT"	CCT, cardiac CTA, cardiac CT angiography
Coronary CT angiography (Coronary CTA)	CT imaging that permits tomographic visualization of the coronary arteries after injection of contrast medium	CCTA, EBCTA, MDCTA
Cardiovascular computed tomography (Cardiovascular CT)	General description for CT imaging of the heart or vasculature; may or may not use ECG-gating or ECG-triggering; may be specified as "noncontrast" or "contrast-enhanced"	CVCT

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Table 1 (continued)

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Coronary calcium scan	Images of the coronary arteries obtained by noncontrast cardiac CT and used to detect and quantify coronary calcium	
Myocardial CT perfusion (Myocardial CTP)	Evaluation of myocardial blood flow or enhancement pattern by computed tomography with the injection of contrast medium; can be modified with the term "first pass" to indicate image acquisition coincident with the initial passage of the contrast material through the heart	MCTP, CT Myocardial perfusion imaging (CT MPI)
Myocardial CT delayed enhancement (Myocardial CTDE)	Delayed imaging after the injection of contrast medium to evaluate for delayed hyperenhancement of myocardium	Delayed hyperenhancement scan, DHE scan, scar imaging

Notes regarding Table 1.

Cardiac computed tomography: This term refers to the use of any form of computed tomographic imaging of the heart that uses the ECG signal for data acquisition or image reconstruction. It may be specified as noncontrast cardiac CT, such as a coronary calcium scan, or contrast-enhanced cardiac CT, such as an evaluation of the cardiac chambers, or of a suspected intracardiac mass. An evaluation of the coronary arteries in particular using cardiac CT has a special designation, *coronary CT angiography*. *Cardiac CT* refers to the topic; the examination procedure and its resultant data are also referred to as a *cardiac CT*.

Coronary CT angiography: This term refers to the use of contrast-enhanced cardiac CT specifically for imaging the coronary arteries. The examination procedure and its resultant data are referred to as a *coronary CT angiogram*, or a *coronary CTA*. The abbreviation CCTA is to be avoided because of its ambiguity.

Coronary calcium scan: A variety of terms have been circulating to refer to this, including *calcium scan*, *coronary calcium scan*, *heart scan*, and *calcium score*. Other terms have referred to the data derived from the procedure, including *calcium score*, *coronary calcium score*, and *coronary artery calcium score*, each contributing to a list of unclear abbreviations (CS, CCS, CACS, CAC score).

Coronary calcium scan provides a more specific term than *calcium scan* or *heart scan*. The use of "score" should refer to the data only, in that the score is derived information obtained from the results of the scan.

Some journals and editors do not accept the term *scan*. In this case, the most precise alternative term that could be used is *noncontrast cardiac CT for measurement of calcified coronary plaque*.

Myocardial CT perfusion and myocardial CT delayed enhancement: The descriptor *imaging* should be added to refer to the topic, or *study*, to refer to the procedure. Hence, the topics should be referred to as *myocardial CT perfusion imaging* or *myocardial CT delayed enhancement imaging*, whereas the procedure and its resultant data should be referred to as a *myocardial CT perfusion study* or a *myocardial CT delayed enhancement study*.

Table 2 Contrast injection and data acquisition

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Contrast transit time	Time required for contrast medium to flow from the injection site to the region of interest	Circulation time, vein to artery travel time, contrast delay
Timing bolus	Small bolus of contrast medium used to determine the contrast transit time	Test bolus, test injection, timing scan
Bolus tracking	Process of monitoring the attenuation in a cross-sectional region of interest after contrast medium injection until the desired attenuation is attained, triggering the start of the scan	Bolus monitoring
Data acquisition or scan	The process of measuring the x-ray attenuation of an object	Image acquisition
Raw data	The x-ray attenuation data measured by a CT system that is used for image reconstruction	X-ray data, attenuation data, scan data, projection data
Axial scan	Data acquisition while the patient table remains stationary; the table position may be incremented between x-ray exposures to collect data over a longer z-axis range	Step and shoot scan
Helical or spiral scan	Data acquisition while the patient table is moving along the z-axis	
Prospectively ECG-triggered	Method for initiating data acquisition at a user-specified point in the cardiac cycle using the ECG signal may be used to describe acquisitions using an axial scan mode (<i>prospectively ECG-triggered axial scanning</i>) or helical scan mode (<i>prospectively ECG-triggered helical scanning</i>)	Triggered cardiac CT step and shoot scan

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Table 2 (continued)

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Retrospectively ECG-gated	Method in which x-ray data are synchronized to a simultaneously recorded x-ray signal throughout the acquisition and images are reconstructed after data acquisition at user-defined points in the cardiac cycle	
Acquisition window	Duration of data acquisition within a single cardiac cycle, often expressed in units of milliseconds (ms); the location of the window is usually described by its position relative to the initial QRS peak in a cardiac cycle; depending on the scanner manufacturer, the location of the window may be described relative to the start of the data acquisition window or the center of the data acquisition window	
Detector coverage	Total z-axis dimension of exposed detector rows expressed in mm. This represents the width of the section of anatomy imaged per gantry rotation at isocenter (eg, 320-row CT scanner with 0.5-mm rows = 160 mm detector coverage at the center of the gantry)	
Detector row width	Active width of 1 detector row in the z-axis direction that corresponds to 1 data acquisition channel, expressed in millimeters within the z-axis (eg, 0.6 mm)	Slice width, slice collimation, detector slice collimation, channel width
Detector configuration	Description of the number and width of active data channels; number of active detector rows multiplied by the individual detector row width, expressed in mm relative to the center of the scan plane (eg, 64×0.6 mm)	Beam collimation, detector collimation
Total nominal beam width	The nominal width of the x-ray beam expressed in mm relative to the center of the scan plane; the numerical value is equivalent to the product of the number of active detector rows and the individual detector row width (eg, 160 mm = 320×0.5 mm)	Beam collimation
Rotation time	Time required for one 360-degree rotation of the CT gantry	
Scan angle	Angular extent of the gantry rotation during which the x-ray beam is on; may be less than, equal to, or greater than 360 degrees; expressed in degrees	
Pitch	Unitless parameter used to describe the table travel during helical/spiral CT; equal to table travel (mm) per gantry rotation \div total nominal beam width (mm)	
Tube potential	The electric potential applied across an x-ray tube to accelerate electrons towards a target material, expressed in units of kilovolts (kV)	
Tube current	Number of electrons accelerated across an x-ray tube per unit time, expressed in units of milliamperes (mA)	mA
Exposure time	Duration of time during which the x-ray beam is on. In axial scan mode, this varies with scan angle, and is calculated as (scan angle \div 360) \times rotation time. In helical scanning, this varies with pitch, detector coverage, and the extent of anatomy to be imaged in the z direction. It reflects the cumulative duration of the entire helical scan	
Tube current-time product	The product of tube current and exposure time per rotation, expressed in units of milliamperes \cdot seconds (mAs). In axial scan mode, this is equal to tube current \times (scan angle \div 360) \times rotation time. In helical scan mode, this is equal to tube current \times rotation time	mAs
Effective tube current-time product	In helical scan mode, this is equal to tube current \times rotation time \div pitch, and is expressed in units of milliamperes \cdot seconds (mAs)	mAs mAs per slice Effective mAs
ECG-based tube current modulation	Modulation of the tube current according to the image reconstruction window within each cardiac cycle	ECG pulsing, dose modulation, tube modulation

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Table 2 (continued)

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (<i>not</i> recommended)
Widened data acquisition window	Acquisition of additional data during axial CT beyond the minimum needed for image reconstruction so as to allow reconstruction of series using different phases	Padding, phase tolerance
Acquisition field of view	Diameter or width of the region within the scan plane that is exposed to x-rays, expressed in units of mm (note that some units display using units of mm or cm)	Scan field of view
Scan length	Distance between start and end of data acquisition along the z-axis (direction of patient movement) for a single scan, expressed in mm	Scan range
Scan time	Total time required to acquire raw data used to reconstruct all images over the entire scan length. In axial scan mode, this includes the time required to increment the table between successive x-ray exposures	Acquisition time

Table 3 Image reconstruction, processing, and analysis

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (<i>not</i> recommended)
Image	A digital representation of a section of anatomy reconstructed from the raw data. The image plane should be specified (axial, coronal, sagittal, or multiplanar)	
Image reconstruction	The mathematical process of generating images from the raw data of a CT scan	
Series	A set of images resulting from a specific CT scan acquisition and reconstruction. Using the same raw data but different reconstruction parameters, multiple series may be reconstructed from a single CT scan	Axial data, axial slices, slices, reconstruction
Exam	The collection of raw data and resulting images from a single patient visit; the entire exam may consist of multiple scans and image series	Image set, study
Image reconstruction window	Duration of time within a single cardiac cycle over which raw data are used for image reconstruction, expressed in milliseconds. The value must be less than that of the data acquisition window	
Phase	Position of the image reconstruction window within the cardiac cycle; usually described by its position relative to the initial QRS peak of the cardiac cycle; may use percentage or absolute time in milliseconds; the position of the window within the cardiac cycle may be referenced to the beginning or center of the image reconstruction window	
Reconstructed field of view	Diameter or width of the region over which image data are reconstructed, typically less than or equal to the acquisition field of view; some systems extrapolate data from within the acquisition field of view to reconstruct a field of view wider than the diameter of the x-ray beam; expressed in mm (some systems report the value in mm or cm)	Display field of view
Reconstructed slice thickness	The nominal thickness of the reconstructed image perpendicular to the reconstruction plane; expressed in mm (eg, for axial images, this is the nominal thickness along the z-axis of the anatomy contained in the reconstructed image); the thickness is relative to the center of the image plane	

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Table 3 (continued)

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Increment	The nominal distance between the centers of consecutively reconstructed slices expressed in mm	
CT number	The numerical value assigned to each pixel in an image; this value represents the average x-ray attenuation of all tissue included in the voxel of anatomy associated with a given pixel relative to water, expressed in Hounsfield units (HU)	CT density, CT attenuation, CT value, attenuation
Hounsfield units (HU)	The unit of measurement for CT numbers, named in honor of the co-inventor of CT, Sir Godfrey Hounsfield. By definition, the CT number of water is 0 HU, and the CT number of air is -1000 HU	
Multicycle reconstruction	Type of image reconstruction that uses raw data from the same phase of 2 or more consecutive cardiac cycles for generation of each image so as to effectively improve temporal resolution at certain heart rates	Multisector reconstruction, multisegment reconstruction
Multiphase reconstruction	The creation of 2 or more series per cardiac cycle to evaluate different time points within the cardiac cycle	
Image processing	Mathematical modification of reconstructed images	Image reconstruction, reformats, post processing
Multiplanar reformat (MPR)	Two-dimensional grayscale image displaying all the pixels in a chosen orthogonal or oblique plane through the imaged volume; typically created from original axial plane images	Multiplanar reconstruction
Curved multiplanar reformat (cMPR)	Two-dimensional grayscale image displaying all the pixels in a curved plane through the imaged volume; typically created from original axial plane images by tracing a path through the center of the anatomical structures of interest	Curved multiplanar reconstruction
Maximum intensity projection (MIP)	Two-dimensional projection through a defined section of the complete imaged volume, displaying only the pixel having the highest CT number along a path orthogonal to the specified section	
Minimum intensity projection (MinIP)	Two-dimensional projection through a defined section of the complete imaged volume, displaying only the pixel having the lowest CT number along a path orthogonal to the specified section	
Volume-rendering technique (VRT)	The process of reconstructing 2-dimensional planar images from a 3-dimensional volume for the purpose of displaying the object in a manner that allows the 3-dimensional nature of the object to be appreciated	
Straightened vessel view	360° visualization of a vessel around an axis of rotation defined by the centerline of the vessel; vessel appears straight and can be displayed in multiple formats (eg, MIP, VRT)	Rotisserie view, longitudinal view, long view

Table 4 Image interpretation, analysis, artifacts, and radiation

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Calcified plaque	Atherosclerotic plaque in which the entire plaque appears as calcium density	Hard plaque
Partially calcified plaque	Atherosclerotic plaque in which there are 2 visible plaque components, one of which is calcified	Mixed plaque
Noncalcified plaque	Atherosclerotic plaque in which the entire plaque is devoid of calcium density	Soft plaque, low-density plaque, fibrous plaque

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Table 4 (continued)

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Agatston score	Value used to quantify calcium identified from CT images; based on the maximum attenuation and area of image pixels with attenuation greater than 130 HU	Calcium score, CS, CCS, CACS, CAC score
Calcium volume	Value used to quantify calcium identified from CT images; based on the number and size of voxels with attenuation greater than a threshold value	Calcium score, volume score
Calcium mass	Value used to quantify the milligrams of calcium identified from CT images; based on a calibration factor and the number, size, and mean CT number of voxels with attenuation greater than a threshold value	Calcium score, calcium mass equivalent, mass score
Beam-hardening artifact	Dark bands or streaks typically originating from a highly attenuating imaged object as a result of changes in the spectral distribution of polychromatic x-rays during transmission through matter	
Partial volume averaging	In CT, the x-ray attenuation values of all materials contained within a single voxel are nonlinearly averaged and represented by a single CT number. The presence of even small amounts of highly attenuating materials in a voxel can dominate the attenuation of other tissues, resulting in a pixel value that is more representative of the most attenuating material, even though it occupies only a part of the volume associated with each pixel. Improved spatial resolution (decreased voxel sizes) can reduce the amount of partial volume averaging	Calcium blooming
Banding	Contrast gradient along the imaged volume resulting from the acquisition of image stacks during slightly different contrast phases; not really an artifact, but a manifestation of changes in contrast concentration over time relative to the time of image acquisition	Banding artifact, slab artifact
Helical interpolation artifact	Artifact caused by mismatch of heart rate and table motion during helical data acquisition characterized by smearing of data in the z-direction and loss of image quality	Banding artifact
Motion artifact	Unsharpness of anatomy owing to cardiac, respiratory, or gross patient motion; typically characterized by blurring or streaking in the axial image plane	Blurring
Misalignment artifact	Type of motion artifact that may result from gross patient motion, respiratory motion, or cardiac motion owing to arrhythmia or variations in heart rate; appears as improper alignment of adjacent images, as visualized along the z-axis	Step artifact, stair-step artifact, misregistration artifact, slab artifact
Volume CT dose index (CTDI _{vol})	A measure of a CT scanner's radiation output. This standardized metric is universally defined and allows comparison of the amount of radiation being used in a scan. It is measured in a cylindrical acrylic phantom of standard size. Volume CTDI does not correspond to absorbed dose to the patient, which varies depending on patient size and the amount of anatomy scanned. Expressed in units of milligray (mGy)	

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Table 4 (continued)

Recommended term (and abbreviation)	Definition and comments	Previous terms and abbreviations (not recommended)
Dose length product (DLP)	A quantity derived by multiplying the volume CTDI with the scan length to represent the cumulative amount of radiation delivered by a scan. Expressed in milligray · centimeters (mGy · cm). DLP does not reflect the cumulative absorbed dose or energy imparted to any specific patient	
Effective dose	An estimate of radiation risk from a nonuniform radiation exposure expressed in terms of a uniform whole-body exposure that takes into account the dose to specific organs and the radiation sensitivity of these organs. The SI unit for effective dose is the millisievert (mSv)	

Notes regarding Table 4.

Calcified plaque vs noncalcified plaque: In the strictest sense, CT can reliably distinguish 2 types of plaques: calcified plaques, and noncalcified plaques. It was recognized that not all plaques are entirely calcified or noncalcified; hence, a calcified plaque can be further described as *partially calcified*, or by its degree of calcification as *minimally calcified* (specks of calcium), *moderately calcified* (approximately half of the plaque calcified), *predominantly calcified* (most of the plaque calcified but still with some visible noncalcified elements), or *completely calcified*. The term *mixed plaque* should be avoided.

Data derived from coronary calcium scans: Currently, there is confusion because of the use of multiple *score* terms. To clarify, the use of *score* was reserved for one methodology only, namely that of Agatston and Janowitz, for which *Agatston score* provides a succinct reference to this specific scoring methodology. *Score* was dropped from terms referring to volume and mass, as these methodologies are meant to be estimates of actual quantities and not scores in the usual sense.

Appendix A

Disclosure of Conflicts of Interest – Writing Group

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