

1

The Invention of the CT Scanner and the Nobel Prize

Chapter at a glance

Computed Tomography: A Definition

Three Major Stages of CT Imaging

 Data Acquisition System

 Image Reconstruction

 Medical Image Management and Processing System (MIMPS)

Invention of the CT Scanner: The Nobel Prize for Pioneers

Godfrey Hounsfield and Alan Cormack

 Hounsfield's Contribution

 Cormack's Contribution

Evolution of CT Scanners Leading to Present-Day Multi-Slice

CT Imaging

References

Rad Tech's Guide to Computed Tomography: Physics and Instrumentation,
First Edition. Euclid Seeram.

© 2026 John Wiley & Sons, Inc. All rights reserved, including rights for text and data mining and training of artificial intelligence technologies or similar technologies. Published 2026 by John Wiley & Sons, Inc.

Computed Tomography: A Definition

Computed Tomography (CT) is an x-ray imaging modality that is based on *tomographic principles*, *image reconstruction mathematics*, and *computer processing* of the data acquired from the patient. This data consists of *radiation attenuation values* which are subsequently converted into electrical signals by the CT scanner detector electronics and sent to the computer for processing. The results of this processing are *cross-sectional images* (“slices”) of the patient’s anatomy displayed on a monitor for viewing and interpretation by an observer. A cross-sectional image is an image of a *transverse axial slice* of the patient, defined as a *slice* that is perpendicular to the longitudinal axis of the body, as shown in Figure 1.1.

Current CT scanners have computer processing capabilities that use these two-dimensional (2D) transverse axial images to generate fully three-dimensional (3D) images, as illustrated in Figure 1.2. Since the image reconstruction requires intensive computer processing, CT is often referred to as “*Computer-Assisted*”

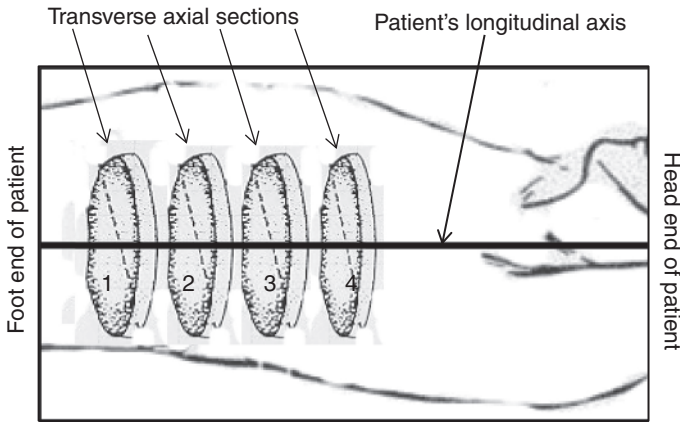


Figure 1.1 CT imaging produces images of transverse axial sections of the patient. Such a section is perpendicular to the longitudinal axis of the body.

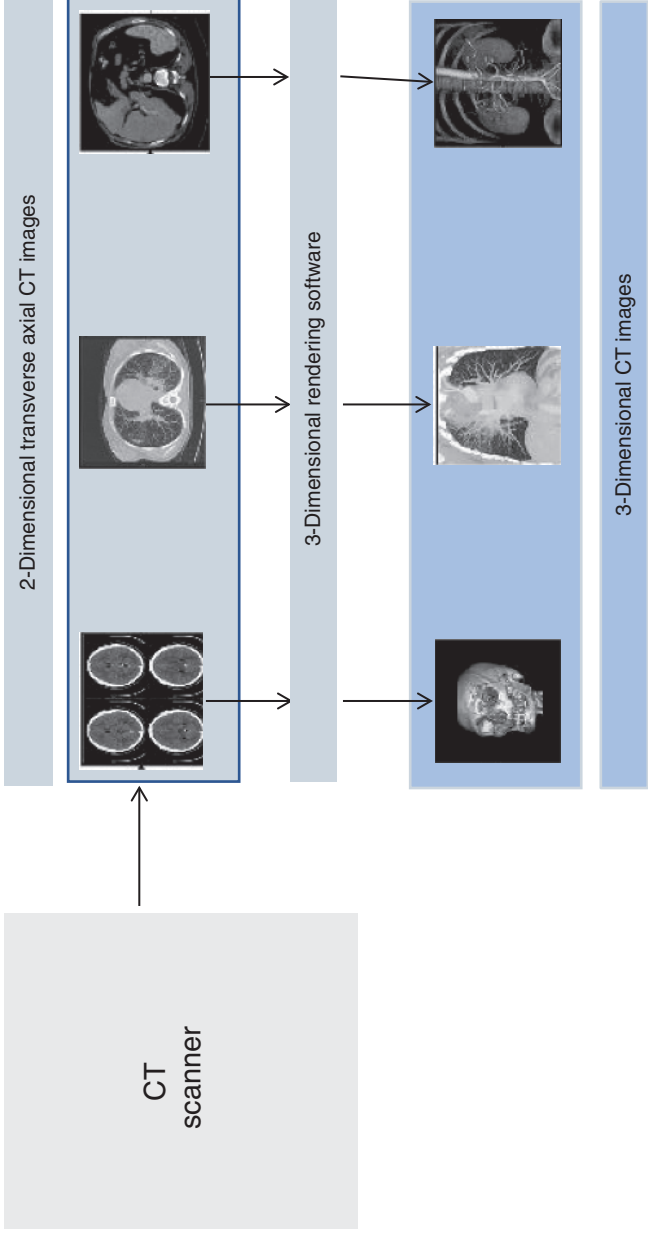


Figure 1.2 Current CT scanners have the processing capabilities to use two-dimensional (2D) transverse axial images to generate fully three-dimensional (3D) images.

Source: Generated with AI using Craiyon LLC.

Tomography,” a term used by the Nobel Prize organization when awarding the Nobel Prize to the CT pioneers [1].

Three Major Stages of CT Imaging

Three major stages of CT imaging include data acquisition, image reconstruction, and image management and processing, the sequence of which is illustrated in Figure 1.3. While *data acquisition* refers to collecting x-ray attenuation values (attenuation coefficients) from the patient as the x-ray tube and detectors rotate around the patient, *image reconstruction* involves the use of extensive mathematics coded in the form of computer programs referred to as *algorithms* to create and build up cross-sectional images of the patient. The third stage of CT imaging involves the display, management, and processing of images obtained from scanning. The latter is now referred to as *Medical Image Management and Processing System (MIMPS)*, which replaces the former technology referred to as *Picture Archiving and Communication System (PACS)*. A further elaboration of Figure 1.3 is illustrated in Figure 1.4.

Data Acquisition System

The main components of the data acquisition system include the x-ray tube, which is coupled to x-ray detectors and detector electronics, that rotate 360° around the patient to collect x-ray *attenuation values* referred to as *linear attenuation coefficients*



Figure 1.3 The three major stages of CT imaging, namely data acquisition, image reconstruction, and image management and processing.

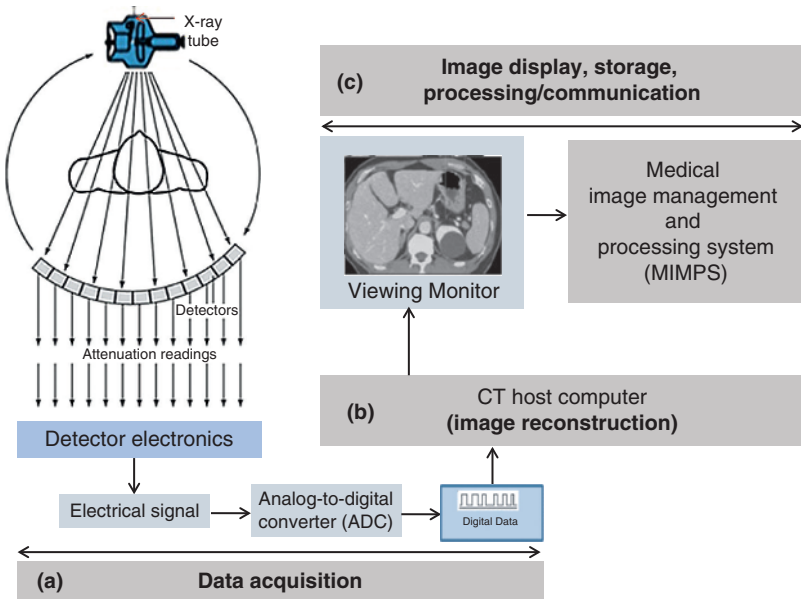


Figure 1.4 An elaboration of the three stages noted in Figure 1.3.

(μ s), as shown in Figure 1.4a. These coefficients are used to compute *integers* (zero, positive, and negative numbers) called *CT numbers* that represent the sectional anatomy of the patient. CT numbers are now referred to as *Hounsfield Units* (HU) in honor of Sir Godfrey Hounsfield, who shared the Nobel Prize with Professor Alan Cormack for their development of Computer-Assisted Tomography [2]. While the essential physics of radiation attenuation will be discussed in Chapter 2, data acquisition will be described in detail in Chapter 3.

Image Reconstruction

The second stage of CT imaging is image reconstruction, which is considered the heart of the CT scanner (Figure 1.4b). Image reconstruction uses mathematics to build up images from the attenuation data acquired from the patient. The mathematics can be coded in the form of *computer algorithms*, which describe

a set of rules for solving a problem. The problem in CT is to calculate the attenuation values obtained from the slices of tissues during data acquisition. These algorithms are complex and have evolved from the *filtered back projection* algorithm, which was used in CT for about five decades, and *iterative reconstruction* algorithms [3–5] developed to reduce noise (hence the dose) in CT images, to reconstruction algorithms based on *artificial intelligence* (AI). AI uses computers to mimic the human cognition system, whereby they are trained to think and solve problems like humans [6, 7]. One such AI-based algorithm is *deep learning reconstruction* algorithm, designed to further reduce the image noise (improved image quality with reduced dose) inherent in iterative algorithms [8, 9]. Essential details of CT image reconstruction will be described in Chapter 4.

Medical Image Management and Processing System (MIMPS)

The third stage of CT imaging includes the *image display* of the reconstructed image for viewing and interpretation, along with postprocessing to suit the needs of the interpreting radiologist. Furthermore, images are sent to the MIMPS for archiving, storage, and communication to virtual data centers for retrospective image analysis. The Food and Drug Administration (FDA) made this change in 2021 in the Cures Act enacted (Pub. L. 114–255) [10] and noted that radiologists pay careful attention to three modifications, namely medical image storage devices, picture archiving and communication systems, and medical image communication devices. More detailed information can be obtained from the FDA document [10]. An important consideration in making this change is that a major feature of MIMPS is image processing operations, including image manipulation, quantification, and three-dimensional (3D) image visualization techniques such as surface rendering and volume rendering [11].

More recently, AI is being integrated into these image management and processing systems, as illustrated in Figure 4.1.5,



Figure 1.5 Essential features of the PACS-AI platform.

Source: Theriault-Lauzier et al. [12] / Elsevier / CC BY 4.0.

which shows the essential features of the PACS-AI platform. As noted by the authors, “the main objective of the platform is to enable automated, near real-time application of AI models on clinical images for use at the point of care. It offers a web application interface that clinicians can use to search for an imaging study stored on the hospital PACS and select a compatible AI model to be applied to the associated images” [12].

This integration will not be discussed further in this book, and therefore, the interested reader should refer to the original article by Theriault-Lauzier et al. [12].

Invention of the CT Scanner: The Nobel Prize for Pioneers Godfrey Hounsfield and Alan Cormack

The invention of the CT scanner is based on the work of several individuals, most notably Sir Godfrey Newbold Hounsfield and Professor Allan MacLeod Cormack. For their work, Hounsfield and Cormack shared the 1979 Nobel Prize in Medicine or Physiology [1]. The literature is replete with information on this invention, and a detailed paper on the invention and development of CT through the years, covering notable milestones, is that of McCollough and Rajiah [13]. Furthermore, the Nobel Prize Organization (<http://www.nobelprize.org>) features remarkable details on the contributions of both these CT pioneers.

Hounsfield's Contribution

After studying electronics, electrical, and mechanical engineering, he gained employment in 1951 as an engineer at Electronic and Musical Industries (EMI) Limited in the United Kingdom, where he initially worked on radar systems and later on computer technology. In 1967, Hounsfield was investigating pattern recognition and reconstruction techniques by using the computer. Sometime later, he explored imaging an

object by x-rays passing an x-ray beam through an object at different angles while collecting x-ray transmission readings, and processing these measurements using the computer. His initial experiments used an americium gamma radiation source coupled with a sodium iodide crystal detector. Data acquisition took about 9 days to collect 28,000 measurements collected by the detector. Computer processing took 2.5 hours. Since this approach was too long, the gamma radiation source was replaced by a diagnostic x-ray tube. The results of these experiments were more accurate and took one day to produce a picture [2].

In 1971, the first clinical prototype CT brain scanner (EMI Mark 1) was installed at Atkinson-Morley's Hospital, and clinical studies were conducted under the direction of Dr. Ambrose. The processing time for the picture was reduced to about 20 minutes. Later, with the introduction of minicomputers, the processing time was reduced further to 4.5 minutes [5]. In 1972, Hounsfield received several prestigious awards, such as Fellowship of the Royal Society and the Lasker Prize in the United States. In 1977, Hounsfield was appointed a Commander of the British Empire, and in 1979, he shared the Nobel Prize in Physiology or Medicine with Allan MacLeod Cormack, a physics professor at Tufts University in Medford, Massachusetts, for their contributions to the development of CT. After receiving this prestigious prize, he was knighted by Her Majesty Queen Elizabeth II and became an Honorary Fellow of the Royal Academy of Engineering. Sir Godfrey Hounsfield died on August 12, 2004, at age 84 [14]. Additional details of Hounsfield's pioneering work can be found in a book entitled *Godfrey Hounsfield: Intuitive Genius of CT* by Bates et al. [15] who were friends of Hounsfield and worked with him at EMI.

Cormack's Contribution

Professor Cormack, on the other hand, developed solutions to the mathematical problems in CT. In 1963 and 1964, he published two papers in the *Journal of Applied Physics* on the subject, but they

received little interest in the scientific community at that time. It was not until Hounsfield began work on the development of the first practical CT scanner that Dr. Cormack's work was also viewed as a pioneering work, and for this contribution, he shared the 1979 Nobel Prize in Physiology or Medicine with Hounsfield. Professor Cormack died at age 74 in Massachusetts on May 7, 1998. While Hounsfield's Nobel lecture is entitled "Computed Medical Imaging," Cormack's Nobel Lecture is entitled "Early Two-Dimensional Reconstruction and Recent Topics Stemming from It." A brief summary of the biographies of Sir Godfrey Hounsfield and Allan Cormack is presented in Table 1.1 [16].

Evolution of CT Scanners Leading to Present-Day Multi-Slice CT Imaging

Recently, CT celebrated 50 years of its history, and articles have been describing *significant milestones* since 1971 [17–21]. An important review is the one by Hsieh and Flohr [19], which addresses three notable CT innovations. These innovations include *isotropic imaging*, developments in *temporal resolution*, and *the acquisition of spectral information*. Subsequently, data acquisition developed from obtaining one slice per revolution of the x-ray tube and detectors to *multi-slice imaging*. The latter is based on obtaining multiple slices in a single breath-hold as the tube and detectors rotate continuously while the patient moves through the gantry. This type of scanning is referred to as *spiral/helical CT scanning*.

The temporal resolution innovation in CT imaging focused on "freezing patient motion and obtaining dynamic information of larger scan ranges with faster gantry rotation, wide-cone CT, dual-source CT (DSCT), larger helical pitch, and advanced algorithms" [19]. Finally, Hsieh and Flohr [19] identified "the third frontier of the CT development," which marked the introduction of "color" in CT images through the use of dual-energy or multi-energy CT imaging [19].

Table 1.1 Brief biographies of the pioneers of the CT scanner.

Sir Godfrey Hounsfield	Professor Allan Cormack
■ 1919 – Born in England	■ 1924 – Born in South Africa
■ 1939 – Joined RAF	■ 1944 – Received BSc in Physics (University of Cape Town)
■ Faraday House (Studied Mechanical and Electrical Engineering)	■ 1945 – MSc in Crystallography
■ 1951 – Joined EMI – Worked on Patten Recognition	■ 1958 – Tufts University
■ 1972 – McRobert Award, -highest honor for innovation	■ 1962 – Developed solutions to the mathematical problem in CT
■ 1975 – Fellow of the Royal Society	■ 1979 – Shared Nobel Prize with Hounsfield for CT
■ 1967 – Commander of the British Empire	■ 1979 – December 8 – Nobel Lecture entitled
■ 1979 – Nobel Prize for invention of the CT Scanner (shared with Cormack)	“Early Two-Dimensional Reconstruction and Recent Topics Stemming from It”
■ 1979 – December 8 – Nobel Lecture entitled “Computed Medical Imaging”	■ 1963–1964 – Published papers in <i>Journal of Applied Physics</i>
■ 1981 – Knighted by HM Queen Elizabeth II	■ 1998 – Passed away at age 74, on May 7th in Massachusetts.
■ 1996 – Retired	■ 2002 – Received the Order of Mapungubwe in South Africa
■ 2004 – Hounsfield passed away at age 84	

Source: Adapted from Seeram [16].

Currently, AI and its sub-fields or sub-sets, namely Machine Learning (ML) and Deep Learning (DL), have now found applications in medical imaging, including not only the CT scanning workflow but also CT image reconstruction [19].

Finally, the *next generation of CT scanners* will be based on *photon counting*. Already, the Food and Drug Administration (FDA) approved two such scanners for clinical use: Siemens NAEOTOM Alpha (the first photon-counting detector CT scanner, approved in September 2021 [22]) and a portable CT scanner from NeuroLogica called OmniTom Elite, in March 2022 [23].

The photon-counting CT scanner overcomes the limitations of conventional energy integrating detectors and offers advantages such as the reduction of electronic noise, better spatial resolution, weighting of photons, improved contrast resolution, low-dose imaging, and material-specific imaging.

Each of the above technologies will be described in the remaining chapters of this book.

For example, multi-slice CT (MSCT) principles and technology as well as photon-counting CT will be described in Chapter 5. While Chapter 6 will outline the principles of image postprocessing, Chapter 7 will address image quality. Radiation dose in CT will be outlined in Chapter 8. Finally, Chapter 9 will describe the elements of CT quality control.

The use of CT imaging in healthcare has been viewed as a revolutionary evolution. The continued innovations in medical physics, biomedical engineering, computer science, and clinical radiology have opened up avenues for several new clinical applications, such as cardiovascular CT (CCT) imaging, for example. CCT has led to applications in coronary CT angiography (cCTA) and calcium scoring, CT fractional flow reserve (CT-FFR), and CT perfusion [24]. Example images of cCTA and CT-FFR are shown in Figures 1.6 and 1.7, respectively. This book will not address clinical applications, which will be covered in another guide of this series called *Rad Tech's Guide to Clinical CT*.

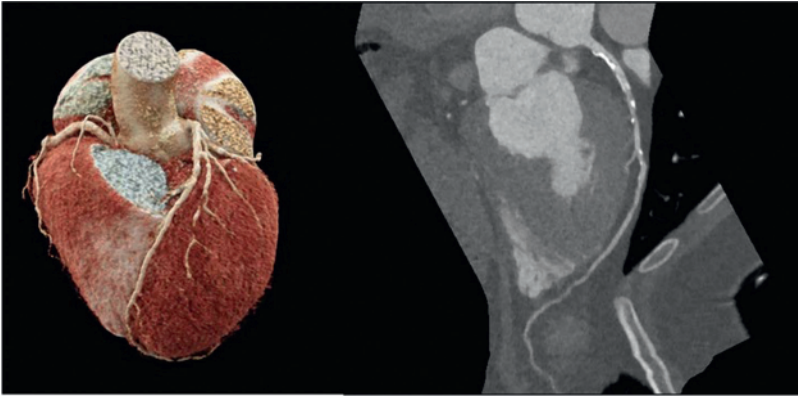


Figure 1.6 CT coronary angiography. The image on the left shows a 3D model of the coronary arteries. The right image displays a radial series of the left anterior descending artery of the same patient with calcified and non-calcified plaque in the proximal segment.

Source: From Schulz et al. [24] / Springer Nature / CC BY 4.0.

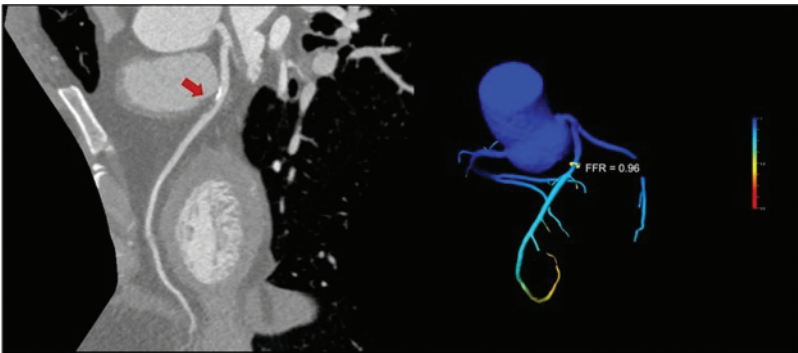


Figure 1.7 Functional testing using CT-FFR. The image on the left shows an intermediate stenosis of the left anterior descending artery by a mixed plaque. Using CT-FFR, as shown on the right, it was possible to exclude hemodynamic relevance of the stenosis.

Source: From Schulz et al. [24] / Springer Nature / CC BY 4.0.

References

1. The Nobel Prize in Physiology or Medicine (1979). Nobel Prize Outreach AB 2023. <https://www.nobelprize.org/prizes/medicine/1979/summary/> (accessed January 2025).
2. Hounsfield, G.N. (1980). Nobel Award address. Computed medical imaging. *Med. Phys.* 7 (4): 283–290. <https://doi.org/10.1118/1.594709>. PMID: 6993911.
3. Seeram, E. (2023). *Computed Tomography: Physical Principles, Patient Care, Clinical Applications, and Quality Control*, 5e. Maryland Heights, MO: Elsevier.
4. Qiu, D. and Seeram, E. (2016). Does iterative reconstruction improve image quality and reduce dose in computed tomography? *Radiol. Open J.* 1 (2): 42–54. <https://doi.org/10.17140/ROJ-1-108>.
5. Bushberg, J.T., Seibert, A.J., Leidholdt, E.M. Jr., and Boone, J.M. (2021). *The Essential Physics of Medical Imaging*, 4e. Philadelphia, PA: Wolters Kluwer.
6. Wooldridge, M. (2018). *Artificial Intelligence*. Ladybird Books Ltd.
7. Wagner, J.B. (2019). Artificial intelligence in medical imaging. *Radiol. Technol.* 90 (5): 489–501.
8. Hsieh, J., Liu, E., Nett, B. et al. (2019) A new era of image reconstruction: TrueFidelity. <https://www.gehealthcare.ru/-/jssmedia/040dd213fa89463287155151fdb01922.pdf> (accessed 20 January 2025).
9. Boedeker, K. (2019). AiCE deep learning reconstruction: bringing the power of ultra-high resolution CT to routine imaging. *Can. Med. Syst.* 2: 28–33.
10. Medical Devices (2021). Medical device classification regulations to conform to medical software provisions in the 21st century cures act: a rule by the Food and Drug Administration on 19 April 2021. <https://www.federalregister.gov/d/2021-07860> (accessed 30 January 2025).
11. Seeram, E., McEntee, M., and Stewart, K.L. (2025). *Imaging Informatics: An Introduction*. Maryland Heights, MO: Elsevier Health Sciences.

12. Theriault-Lauzier, P., Cobin, D., Tastet, O. et al. (2024). A responsible framework for applying artificial intelligence on medical images and signals at the point of care: the PACS-AI platform. *Can. J. Cardiol.* 40 (10): 1828–1840.
13. McCollough, C.H. and Rajiah, P.S. (2023). Milestones in CT: past, present, and future. *Radiology* 309 (1): e230803. <https://doi.org/10.1148/radiol.23080>.
14. Isherwood, I. (2004). Sir Godfrey Newbold Hounsfield—in memoriam. *Eur. Radiol.* 14: 2152–2153.
15. Bates, S., Beckman, L., Thomas, A., and Waltham, R. (2012). Godfrey Hounsfield: intuitive genius of CT. *Br. J. Radiol.* 85 (1019): e1165.
16. Seeram, E. (2018). *CT at a Glance*. Oxford, UK: Wiley-Blackwell.
17. Naidoo, D. and Mochan, A. (2022). Celebrating 50 years of the first human CT scan: the untold South African connection. *WJCM* 4 (2): 99–102. <https://doi.org/10.18772/26180197.2022.v4n2a5>.
18. Dillon, W.P. (2021 Sep). 50th anniversary of computed tomography: past and future applications in clinical neuroscience. *J. Med. Imaging (Bellingham)* 8 (5): 052112. <https://doi.org/10.1117/1.JMI.8.5.052112>. PMID: 34676278; PMCID: PMC8523063.
19. Hsieh, J. and Flohr, T. (2021). Computed tomography recent history and future perspectives. *J. Med. Imaging* 8 (5): 052109. <https://doi.org/10.1117/1.JMI.8.5.052109>.
20. Sharma, A. and Gulati, V. (2023). 1.23: Advancements in CT technology. <https://radiologykey.com/advancements-in-ct-technology/> (accessed February 2025).
21. Taschetta-Millane, M. (2023). Advancements in computed tomography technology. *Imaging Technology News*, November 2023. <https://www.itnonline.com/article/advancements-computed-tomography-technology>.
22. US Food and Drug Administration (2022). FDA clears first major imaging device advancement for computed tomography in nearly a decade. <https://www.prnewswire.com/news-releases/fda-clears-first-major-imaging-device-advancement-for-computed-tomography-in-nearly-a-decade-301389131.html> (accessed 1 November 2022).

16 Rad Tech's Guide to Computed Tomography

23. Samsung Newsroom (2022). NeuroLogica announces FDA 510(k) clearance for photon counting computed tomography using OmniTom Elite. <https://news.samsung.com/global/neurologica-announces-fda-510k-clearance-for-photon-counting-computed-tomography-using-omnitom-elite> (accessed February 2025).
24. Schulz, A., Otton, J., Hussain, T. et al. (2024). Clinical advances in cardiovascular computed tomography: from present applications to promising developments. *Curr. Cardiol. Rep.* 26: 1063–1076. <https://doi.org/10.1007/s11886-024-02110-w>.