Review Article

The role of iodinated contrast media in computed tomography structured Reporting and Data Systems (RADS): a narrative review

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Background and Objective: In recent years, there has been a large-scale dissemination of guidelines in radiology in the form of Reporting & Data Systems (RADS). The use of iodinated contrast media (ICM) has a fundamental role in enhancing the diagnostic capabilities of computed tomography (CT) but poses certain risks. The scope of the present review is to summarize the current role of ICM only in clinical reporting guidelines for CT that have adopted the "RADS" approach, focusing on three specific questions per each RADS: (I) what is the scope of the scoring system; (II) how is ICM used in the scoring system; (III) what is the impact of ICM enhancement on the scoring.

Methods: We analyzed the original articles for each of the latest versions of RADS that can be used in CT [PubMed articles between January, 2005 and March, 2023 in English and American College of Radiology (ACR) official website].

Key Content and Findings: We found 14 RADS suitable for use in CT out of 28 RADS described in the literature. Four RADS were validated by the ACR: Colonography-RADS (C-RADS), Liver Imaging-RADS (LI-RADS), Lung CT Screening-RADS (Lung-RADS), and Neck Imaging-RADS (NI-RADS). One RADS was validated by the ACR in collaboration with other cardiovascular scientific societies: Coronary Artery Disease-RADS 2.0 (CAD-RADS). Nine RADS were proposed by other scientific groups: Bone Tumor Imaging-RADS (BTI-RADS), Bone-RADS, Coronary Artery Calcium Data & Reporting System (CAC-DRS), Coronavirus Disease 2019 Imaging-RADS (COVID-RADS), COVID-19-RADS (CO-RADS), Interstitial Lung Fibrosis Imaging-RADS (ILF-RADS), Lung-RADS (LU-RADS), Node-RADS, and Viral Pneumonia Imaging-RADS (VP-RADS).

Conclusions: This overview suggests that ICM is not strictly necessary for the study of bones and calcifications (CAC-DRS, BTI-RADS, Bone-RADS), lung parenchyma (Lung-RADS, LU-RADS, COVID-RADS, CO-RADS, VP-RADS and ILF-RADS), and in CT colonography (C-RADS). On the other hand,

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ICM plays a key role in CT angiography (CAD-RADS), in the study of liver parenchyma (LI-RADS), and in the evaluation of soft tissues and lymph nodes (NI-RADS, Node-RADS). Future studies are needed in order to evaluate the impact of the new iodinated and non-iodinate contrast media, artificial intelligence tools and dual energy CT in the assignment of RADS scores.

Keywords: Computed tomography (CT); iodinated contrast media (ICM); Reporting & Data Systems (RADS); radiology

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Introduction

Contrast-enhanced computed tomography (CT) imaging is a widely used diagnostic tool for evaluating a variety of medical conditions (1-5). However, the interpretation of CT scans can be subjective and may vary between radiologists. The American College of Radiology (ACR) developed the Reporting and Data Systems (RADS) to standardize the reporting and interpretation of imaging findings in radiology, including CT examinations (6). The implementation of RADS in clinical practice has been shown to improve the consistency and accuracy of imaging interpretation, leading to greater interobserver agreement among radiologists, more consistent recommendations for follow-up imaging and management, improving communication between radiologists and referring physicians (7-10). Since their introduction, RADS have been expanded to include several areas of CT imaging and have been updated to reflect advances in technology and changes in clinical practice also thanks to the implementation of RADS by scientific groups other than the ACR.

The use of iodinated contrast media (ICM) has a fundamental role in enhancing the diagnostic capabilities of CT imaging, as follows:

(I) It can improve the sensitivity and specificity of CT scans, allowing the detection of small lesions and a more accurate diagnosis of diseases;
(II) It can help to differentiate between benign and malignant lesions, as well as assess the extent of disease involvement;
(III) It can be used to evaluate vascular structures and perfusion;
(IV) It can be used in the assessment of abdominal and pelvic organs, also for the detection and characterization of solid and cystic masses.

On the other hand, the use of ICM in CT imaging poses certain risks: the most common adverse reactions to ICM include allergic reactions (11), which range from mild to severe and can be life-threatening (12); other adverse reactions include nephrotoxicity (13), which can lead to acute kidney injury or worsening of pre-existing renal dysfunction (hence it is suggested to assess renal function before examination), and contrast-induced thyroid dysfunction, although this is rare and typically only occurs in patients with pre-existing thyroid disease (14-16). In addition, the use of ICM requires several infrastructures (e.g., additional staff, cannulas, and contrast injectors), increasing the cost and examination time.

The purpose of this work is to provide an overview of the current need for ICM to fulfill the CT clinical reporting guidelines following the "RADS" approach. This will be achieved by addressing three specific points for each RADS: (I) the scoring system's scope; (II) the modality of use of ICM in the scoring system; and (III) the effect of ICM enhancement on the scoring. We present this article in accordance with the Narrative Review reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-23-603/rc).

Methods

MP identified 24 RADS through official websites (6,17); a subsequent search on PubMed (timeframe between January 1, 2005 and March 4, 2023) was performed, identifying 4 additional RADS in the literature. All authors attended a meeting to discuss the literature selection and obtained the consensus. So, we selected a total of 28 RADS, of which 14 were excluded because they did not involve CT. In the final analysis, we found 14 RADS suitable for use in CT out of 28 RADS described in the literature. See *Figure 1* for the

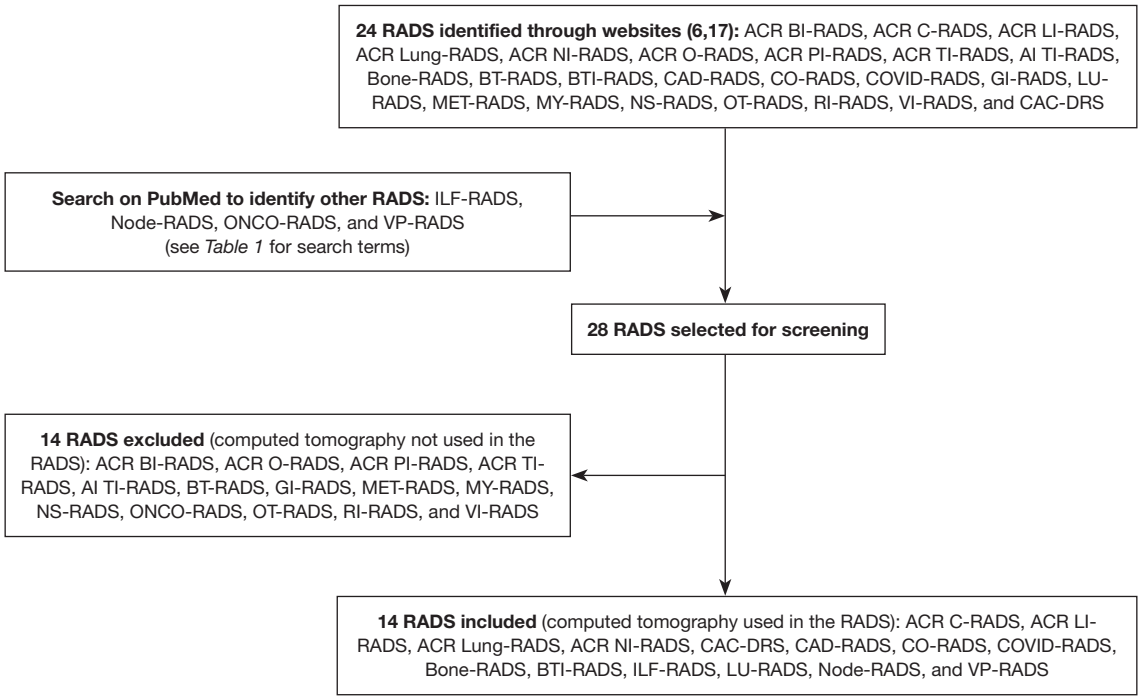

Figure 1 Flow diagram of the search strategy and study selection. RADS, Reporting & Data Systems; ACR BI-RADS, American College of Radiology Breast Imaging-RADS; ACR C-RADS, American College of Radiology CT Colonography-RADS; ACR LI-RADS, American College of Radiology Liver Imaging-RADS; ACR Lung-RADS, American College of Radiology Lung CT Screening-RADS; ACR NI-RADS, American College of Radiology Neck Imaging-RADS; ACR O-RADS, American College of Radiology Ovarian-Adnexal Imaging RADS; ACR PI-RADS, American College of Radiology Prostate Imaging-RADS; ACR TI-RADS, American College of Radiology Thyroid Imaging-RADS; AI TI-RADS Artificial Intelligence-Thyroid Imaging-RADS; BT-RADS, Brain Tumor RADS; BTI-RADS, Bone Tumor Imaging-RADS; CAC-DRS, Coronary Artery Calcium-Data & Reporting System; CAD-RADS 2.0, Coronary Artery Disease-RADS; CO-RADS, COVID-19-RADS; COVID-RADS, Coronavirus Disease 2019 Imaging-RADS; GI-RADS, Gynecologic Imaging RADS; ILF-RADS, Interstitial Lung Fibrosis Imaging-RADS; LU-RADS, Lung RADS; MET-RADS, METastasis RADS; MY-RADS, MYeloma Response Assessment & Diagnosis System; NS-RADS, Neuropathy Score RADS; ONCO-RADS, Oncologically Relevant Findings RADS; OT-RADS, Osseous Tumor RADS; RI-RADS, Reason for exam Imaging RADS; VI-RADS, Vesical Imaging RADS; VP-RADS, Viral Pneumonia Imaging-RADS.

flow diagram of the search strategy and study selection and *Table 1* for search strategy details.

We analyzed the original articles for each of the latest versions of included RADS. Four RADS were validated by the ACR: American College of Radiology CT Colonography-Reporting & Data System (ACR C-RADS) (18-20), American College of Radiology Liver Imaging-Reporting & Data System (ACR LI-RADS) version 2018 (21), American College of Radiology Lung CT Screening-Reporting & Data System (ACR Lung-RADS) version 2022 (22), and American College of Radiology Neck Imaging-Reporting & Data System (ACR NI-RADS) (23).

One RADS was validated by the ACR in collaboration with the Society of Cardiovascular Computed Tomography, the American College of Cardiology, and the North America Society of Cardiovascular Imaging: Coronary Artery Disease-Reporting & Data System (CAD-RADS 2.0) version 2022 (24).

Nine RADS were proposed by other scientific groups: Bone Tumor Imaging-Reporting & Data System (BTI-RADS) (25), Bone-Reporting & Data System (Bone-RADS) (26), Coronary Artery Calcium-Data & Reporting System (CAC-DRS) (27), Coronavirus Disease 2019 Imaging-Reporting & Data system (COVID-RADS) (28), COVID-19 Reporting & Data System (CO-RADS) (29), Interstitial Lung Fibrosis Imaging-Reporting & Data System (ILF-RADS) (30), Lung-Reporting & Data System (LU-RADS) (31), Node-

Table 1 The search strategy summary

Items	Specification
Date of search	2023/01/15–2023/03/04
Databases and other sources searched	PubMed and American College of Radiology official website (https://www.acr.org/Clinical-Resources/Reporting-and-Data-Systems)
Search terms used	(Reporting and Data Systems) OR (RADS) OR (-RADS) OR (Reporting & Data Systems); (-RADS[Title]) NOT (C-RADS) NOT (Lung-RADS) NOT (PI-RADS) NOT (BI-RADS) NOT (LI-RADS) NOT (NI-RADS) NOT (O-RADS) NOT (TI-RADS) NOT (Bone-RADS) NOT (BT-RADS) NOT (BTI-RADS) NOT (CAD-RADS) NOT (CO-RADS) NOT (COVID-RADS) NOT (GI-RADS) NOT (LU-RADS) NOT (MET-RADS) NOT (MY-RADS) NOT (NS-RADS) NOT (OT-RADS) NOT (RI-RADS) NOT (VI-RADS) NOT (CAC-DRS)
Timeframe	2005–2023
Inclusion and exclusion criteria	Inclusion criteria: original articles proposing a "RADS" approach, usable in CT. Exclusion criteria: original articles proposing a "RADS" approach, not usable in CT
Selection process	Marco Parillo conducted the selection, all authors attended a meeting to discuss the literature selection and obtained the consensus

RADS, Reporting and Data Systems; CT, computed tomography.

Reporting & Data System 1.0 (Node-RADS) (32), and Viral Pneumonia Imaging-Reporting & Data System (VP-RADS) (33).

Current RADS used in CT

In this section we grouped the RADS based on the organ investigated. *Table 2* outlines the primary RADS currently used in CT and the role of ICM.

Neck

ACR NI-RADS (23)

(I) To standardize the reporting and interpretation of neck imaging studies in the surveillance of head and neck cancer patients. NI-RADS was initially designed for contrast-enhanced CT with or without positron emission tomography (PET). Magnetic resonance imaging (MRI)-specific category descriptors and imaging findings were published in late 2021.

(II) ICM is mandatory in the standard CT protocol, but further technical details (such as the widespread use of a split bolus) are not specified.

(III) ICM administration is crucial in the assessment of the primary site and the neck (i.e., cervical lymph nodes), for each of which a category of 1–4 is assigned to stratify the risk of residual or recurrent disease. Recommendations for surveillance are also based on these categories.

Lymphnodes

Node-RADS (32)

(I) To provide a standardized imaging-criteria based concept for assessing the likelihood of cancer involvement in regional and distant lymph nodes in all body regions. Its use is intended to facilitate reporting and enhance consensus among radiologists in primary staging and response assessment settings. Node-RADS applies to MRI and/or CT.

(II) Contrast administration is not necessary for MRI due to its high soft tissue contrast. However, for CT imaging, an acquisition during an appropriate parenchymal phase after intravenous administration of ICM is required. To make Node-RADS broadly applicable, no specific imaging delays or phases beyond parenchymal enhancement are predefined.

(III) ICM is mandatory to properly evaluate the "configuration" criterion, which is crucial for assigning the Node-RADS score. Specifically, the texture features of a lymph node, which can range from homogeneous to focal or gross necrosis, impact the Node-RADS score.

Table 2 Summary of the main RADS currently used in CT and the role of the contrast medium for each, listed in alphabetical order

CT RADS	Clinical indication	Scope	Contrast enhancement
ACR C-RADS (18-20)	Colon cancer	Diagnosis—colorectal cancer screening with CT colonography	Not required
ACR LI-RADS (21)	Liver cancer	Diagnosis—hepatocellular carcinoma screening and evaluation of response to locoregional treatment	Required (multiphase)
ACR Lung-RADS (22)	Lung cancer	Diagnosis—lung cancer screening with chest CT	Not required
ACR NI-RADS (23)	Head and neck cancer	Surveillance—recurrence evaluation in treated head and neck cancer	Required
Bone-RADS (26)	Bone lesion	Diagnosis—classify benign and malignant solitary bone lesions	Not required
BTI-RADS (25)	Bone lesion	Diagnosis—classify benign and malignant solitary bone lesions	Not required
CAC-DRS (27)	Coronary artery calcium	Diagnosis—coronary artery calcium evaluation in both gated and non-gated chest CT scans	Not required
CAD-RADS 2.0 (24)	Coronary artery disease	Diagnosis—standardize the reporting of coronary CT angiography	Required
COVID-RADS (28)	COVID-19	Diagnosis—lung involvement in patients with suspected COVID-19	Not required
CO-RADS (29)	COVID-19	Diagnosis—lung involvement in patients with suspected or confirmed COVID-19	Not required
ILF-RADS (30)	Interstitial lung disease	Diagnosis—interstitial lung disease diagnosis with high-resolution chest CT	Not required
LU-RADS (31)	Lung cancer	Diagnosis—lung cancer screening with chest CT	Not required
Node-RADS (32)	Lymph nodes in cancer	Diagnosis—risk of cancer involvement in regional and distant lymph nodes	Required (parenchymal phase)
VP-RADS (33)	COVID-19	Diagnosis—lung involvement in patients with suspected or confirmed COVID-19	Not required

RADS, Reporting & Data Systems; CT, computed tomography; ACR C-RADS, American College of Radiology CT Colonography-Reporting & Data System; ACR LI-RADS, American College of Radiology Liver Imaging-Reporting & Data System; ACR Lung-RADS, American College of Radiology Lung CT Screening-Reporting & Data System; ACR NI-RADS, American College of Radiology Neck Imaging-Reporting & Data System; BTI-RADS, Bone Tumor Imaging Reporting & Data System; CAC-DRS, Coronary Artery Calcium-Data & Reporting System; CAD-RADS 2.0, Coronary Artery Disease-Reporting & Data System; COVID-RADS, Coronavirus Disease 2019 Imaging-Reporting & Data system; CO-RADS, COVID-19-Reporting & Data System; ILF-RADS, Interstitial Lung Fibrosis Imaging-Reporting & Data System; LU-RADS, Lung Reporting & Data System; Node-RADS, Node Reporting & Data System; VP-RADS, Viral Pneumonia Imaging-Reporting & Data System.

Lung

In this subgroup, 2 RADS can be used in the context of lung cancer screening (ACR Lung-RADS v2022 and LU-RADS), 3 RADS can be used in the context of COVID-19 (COVID-RADS, CO-RADS, and VP-RADS), and 1 RADS can be used to classify patients with interstitial lung disease (ILF-RADS). ACR Lung-RADS represents the most up-to-date classification regarding chest CT for lung cancer screening (November 2022) and advocates the use of ICM when very suspicious findings or incidental findings are found, unlike LU-RADS where the use of ICM is not clearly indicated. In COVID-RADS, CO-RADS, and ILF-RADS the ICM can be useful to assess the pulmonary arterial circulation, covering patients at increased thrombotic risk; VP-RADS does not mention the use of ICM.

ACR Lung-RADS v2022 (22)

(I) To standardize language for reporting lung cancer screening CT scans, recommending follow-up or additional imaging based on the category.
(II) Intravenous ICM is not required for screening lung CT.
(III) ICM administration can be useful when very

suspicious findings (4B) or incidental findings are reported on a screening CT scan.

LU-RADS (31)

(I) To standardize language for reporting lung cancer screening chest CT scans, recommending follow-up, additional imaging or biopsy based on the category.
(II) Intravenous ICM is not required for screening lung CT.
(III) ICM administration is not included in management recommendations in any category.

COVID-RADS (28)

(I) To standardize the reporting of chest CT findings in patients with suspected Coronavirus Disease 2019.
(II) ICM is not required for the assessment of any findings (atypical, fairly typical, or typical) in order to assign the final score (from 0 to 3).
(III) ICM administration is useful if a CT pulmonary angiogram is indicated.

CO-RADS (29)

(I) To standardize the reporting of chest CT findings in patients with suspected or confirmed Coronavirus Disease 2019.
(II) ICM is not required for the assessment of pulmonary involvement in order to assign the final score (from 0 to 6).
(III) ICM administration is useful if a CT pulmonary angiogram is indicated.

VP-RADS (33)

(I) To standardize the reporting of chest CT findings in patients with suspected or confirmed Coronavirus Disease 2019.
(II) ICM is not required for the assessment of pulmonary involvement in order to assign the final category (from 0 to 4).
(III) ICM administration is not included in management recommendations in any category.

ILF-RADS (30)

(I) To standardize the reporting of high-resolution chest CT imaging for the diagnosis of interstitial lung disease.
(II) ICM is not required for the assessment of interstitial lung disease pulmonary findings in order to assign the final score (from 0 to 4).
(III) ICM administration is useful for the better characterization of extra-pulmonary findings, especially when pulmonary embolism is suspected.

Heart

CAC-DRS can be used to quantify the CAC in unenhanced chest CT scans; on the other hand, CAD-RADS necessarily requires ICM administration as it is used for the reporting of coronary CT angiography (CCTA).

CAC-DRS (27)

(I) To standardize the reporting of CAC in both gated and non-gated chest CT scans.
(II) ICM is not required for CAC evaluation using both the Agatston score and the Visual score (from 0 to 3).
(III) ICM is necessary if, subsequently, a full CCTA study is required.

CAD-RADS 2.0 v2022 (24)

(I) To standardize reporting of CCTA results and provide clear recommendations to referring physicians for subsequent patient management.
(II) ICM is required, being an angiographic study. The unenhanced scan is useful for CAC quantification.
(III) ICM is mandatory to assess the degree of coronary stenosis (CAD-RADS from 0 to 5) and to evaluate any stents or grafts; in addition, the administration of contrast medium is used to assess the Modifier "I", indicating that an ischemia test has been performed (either stress myocardial CT perfusion or CT-fractional-flow reserve).

Liver

ACR LI-RADS v2018 (21)

(I) To provide a consistent and standardized method of interpreting and reporting imaging studies of the liver in patients at risk for hepatocellular carcinoma (HCC), linking assessment categories to management recommendations. It also facilitates the evaluation of HCC responses to locoregional treatments. The score is applicable to contrast-enhanced MRI, ultrasound, contrast-enhanced ultrasound, ultrasound, and contrast-enhanced CT. The choice of contrast agent depends on patient

preference, tolerance, and safety.

(II) Post-contrast multiphase imaging is mandatory. Bolus tracking is suggested with a threshold aortic enhancement of 100–150 HU. The minimum for required phases is: arterial phase (late arterial phase after 15–30 s from reaching the threshold is strongly preferred), a portal venous phase (60–75 s after starting injection) and a delayed phase (typically acquired 2 to 5 minutes after injection). An unenhanced scan is suggested if patient has had locoregional treatment to differentiate tumor enhancement from intrinsic post-treatment hyperattenuation (e.g., iodized oil, proteinaceous, or blood).

(III) Multiphase imaging is mandatory to assess LI-RADS major features: rim and nonrim arterial phase hyperenhancement, peripheral or non-peripheral washout (in the portal phase and especially in the delayed phase), and the presence of an enhancing capsule (in the portal phase and especially in the delayed phase). Investigation of some ancillary features also requires contrast-enhancement, such as corona enhancement (late arterial phase or early portal phase), mosaic appearance (all phases), nonenhancing capsule (all phases), and parallel blood pool enhancement (all phases). In addition, the administration of ICM helps to identify a targetoid appearance (corresponding to the "malignant" or LR-M category, suggestive of malignancy but not HCC specific) and venous thrombus enhancement (referred to as "tumor-in-vein" or LR-TIV). Hence, contrast media administration plays a crucial role in the final assignment of the category (from LR-1 to LR-5, including LR-M and LR-TIV) and identifying any viable tumor in the post-treatment LI-RADS evaluation.

Large bowel

ACR C-RADS (18-20)

(I) To standardize the reporting of both colorectal and extra-colonic findings in patients undergoing screening CT colonography.

(II) Intravenous ICM is not required for CT colonography.

(III) ICM administration can be beneficial for cancer staging in cases where a new cancer lesion is detected during the examination or when CT colonography is performed on a known colorectal cancer, as well as for the characterization of significant extra-colonic findings (E3, E4).

Bone

BTI-RADS or Bone-RADS can be used for the evaluation of solitary bone lesions in CT; in both cases ICM is not required.

BTI-RADS (25)

(I) To provide a classification system of solitary bone lesions based on various benign and malignant indicators that can be used both in CT and MRI.

(II) Intravenous ICM is not required for bone evaluation in all categories (from I to IV), unlike MRI where the absence of contrast-enhancement is classified as a benign indicator.

(III) Intravenous ICM is not included in benign, malignant, and indeterminate features.

Bone-RADS (26)

(I) To provide diagnostic management algorithms for incidental solitary bone lesions in adults that are encountered during CT and MRI imaging.

(II) Intravenous ICM is not required for bone evaluation in all categories (from 1 to 4), unlike MRI where enhancement is often useful to distinguish cystic from non-cystic lesions and to evaluate local tumor extent.

(III) When possible, lesion density values should be evaluated on unenhanced images to prevent the effect of ICM in raising the density of lesions and potentially mimicking a bone lesion.

Discussion

This overview suggests that ICM is not strictly necessary for the study of bones and calcifications, lung parenchyma, and in CT colonography. On the other hand, ICM plays a key role in CT angiography, in the study of liver parenchyma, and in the evaluation of soft tissues and lymph nodes.

Low-osmolar ICM have been widely used for more than two decades due to their established safety and efficacy, unlike MRI contrast agents which have undergone significant innovation over the same period (34). The only approved dimeric ICM, iodixanol, has an iso-osmolar

formulation but is more viscous than the monomeric agents (35). However, two new nonionic dimeric ICM, iosimenol and ioforminol, are currently in clinical development. Iosimenol has a slightly higher iodine concentration and lower viscosity than iodixanol, while ioforminol has a lower osmolality but comparable viscosity to iodixanol (36-38). In addition, there have been recent developments in the synthesis and testing of X-ray contrast media. These prototypes contain tungsten, tantalum, bismuth, or hafnium, which have higher k-edge energies than iodine and are better suited as absorbing elements (39). Consequently, they lead to significantly higher attenuation and CT signal than iodine in the typical CT energy range of 100 to 140 kV. While gold-based nanoparticles have also demonstrated high X-ray attenuation, their longer blood half-life, incomplete excretion, and tendency to be retained in the kidney and liver may limit their use. These non-iodinated X-ray contrast media are still in the experimental research phase and need to demonstrate their diagnostic efficacy and safety worldwide. Moreover, given the current low prices of available ICM, developing these new X-ray contrast media will be a challenging task for manufacturers, considering their high development costs (35,39).

Dual energy CT is a medical imaging technique that uses two different energy levels of X-rays to produce more detailed images of the body's tissues and structures, becoming increasingly common in clinical practice (40). Among the various applications, virtual monochromatic images or material decomposition techniques, such as iodine images, enhance the capability to identify lesions that are either hyper- or hypo-vascular (41). Although dual energy CT is not currently mentioned as a technique in RADS, it is reasonable to assume that it may play an important role within these scores in the near future.

Another aspect to consider relates to the increasing use of artificial intelligence in radiology (42,43), also in the field of RADS. This trend will likely promote the widespread use of scoring systems and could potentially limit the amount of contrast medium required for scoring. In general, deep learning models have the capability to produce synthetic contrast-enhanced CT images using non-contrast or low-dose ICM administration, or generate unenhanced CT images from contrast-enhanced CT scans. Nevertheless, it remains uncertain whether unenhanced CT scans consistently provide enough information to distinguish between hyper-enhancing, hypo-enhancing, and non-enhancing regions in all diagnostic scenarios; so, additional efforts are required to improve protocols aimed at minimizing or eliminating the use of ICM for specific medical conditions and to evaluate the clinical usefulness of these synthetic images (44). Few studies have directly evaluated the validity of artificial intelligence in assigning a RADS in CT. For instance, in the case of LI-RADS, both deep learning and radiomics have shown excellent performance in classifying liver nodules (45). In CAD-RADS, a deep learning model was able to identify stenoses ≥50% with comparable performance to that of experienced radiologists (46). Furthermore, artificial intelligence techniques applied to CCTA interpretation have demonstrated high agreement with expert readers in determining coronary stenosis and CAD-RADS category (47), and a deep convolutional neural network has shown to provide precise CAD-RADS classification (48).

Future studies are necessary to evaluate the impact of using the new X-ray contrast media (both iodinated and non-iodinated) on the longitudinal assessment of cancer patients because comparing examinations performed with contrast media of different classes could have implications for RADS scoring. In addition, artificial intelligence and dual energy CT could also be valuable aids in reducing the dose of contrast medium and helping the radiologist in assigning the correct score. Thus, RADS will be dynamic and rapidly changing in the years to come, along with clinical and technical developments in radiology.

Conclusions

- ICM plays a key role in LI-RADS, NI-RADS, CAD-RADS, and Node-RADS.
- ICM is not required in C-RADS, CAC-DRS, BTI-RADS, Bone-RADS, Lung-RADS, LU-RADS, COVID-RADS, CO-RADS, VP-RADS, and ILF-RADS.
- Future studies are needed in order to evaluate the impact of the new iodinated and non-iodinate contrast media, artificial intelligence tools, and dual energy CT on the assignment of RADS scores.

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Footnote

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at https://

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-23-603/coif). CAM serves as an unpaid editorial board member of *Quantitative Imaging in Medicine and Surgery*. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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