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Multi-Slice CT (MSCT) Spiral Computed Tomography Diagnostic Value of Cardiac Diseases

Sara Khalifa[1*], Mohamed Yousef[1,2], Ikhlas Abdelaziz[1], Awadia Gareeballa[3], Mohammed Salih[4]
[1]College of Medical Radiological Sciences, Sudan University of science and Technology, Khartoum, Sudan
[2]Batterjee Medical College, Department of Radiological Science, Jeddah, Saudi Arabia
[3]Faculty of Radiological Sciences and Medical Imaging, Alazhari University, Khartoum, Sudan
[4]Al-Ghad International College for Applied Medical Science, Medical Imaging Technology Department, Abha, KSA

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***Corresponding author**
Sara Khalifa

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Abstract: The aim of this study was to evaluate the value of multi-slice spiral computed tomography (MSCT) in the diagnosis of cardiac diseases. Clinical and imaging data from 135 patients (73 males and 62females) their ages ranged (18-80 mean 56) years, Non-contrast study (Ca Score) was performed followed by 64-128 detector during 5 seconds breath hold. This study was done at the National Ribat hospital- Omer Sawi complex, Royal scan Diagnostic Centers and other Sudanese hospitals- Khartoum Sudan during the period from 2016 to 2018. The results of this study revealed that 135 patient with different complain CA CT 39 of them were normal, this study we had 8 patient had atherosclerotic plaques 5 of them were calcified 2were noncalcified and only one was mixed, the prevalence of the ca score excessive 9 mild 2 minimal 1 moderate 15 normal 5 total of 37, left coronary artery diseases were more common than right coronary artery anomalies. Male to female ratio was 54.1 to 45.9. It concluded that although further work is required to determine the prognostic utility of MSCT and to clarify its precise clinical role, the currently available data suggest that it will play an increasing role in the evaluation of patients with known or suspected CAD.
Keywords: Coronary artery stenosis, plaques, Computed tomography, Coronary angiography.

INTRODUCTION

Cardiovascular diseases are the most common causes of premature death in the general population. A major fraction is attributable to coronary artery disease which may result in sudden cardiac death. In approximately 50%of patient's myocardial infarction is the first sign of coronary Atherosclerosis and more than 50% of patients suffering an acute myocardial event die within the first month after onset of the acute phase [1].

Coronary artery disease (CAD) is the leading cause of death in Western countries Invasive coronary angiography is the gold standard technique for diagnostic and therapeutic purposes in CAD, owing to its superior Catheter-based invasive coronary angiography (ICA) is the gold standard of reference technique for direct assessment of the severity of coronary stenosis.

However, this applied tool can be associated with certain risks and complications. It should also be possible to more accurately determine the absence or presence of stenotic lesions and to rule out atherosclerotic changes at coronary bypass anastomoses [2]. The use of noninvasive assessment tools was recently considered mainly because it offers safety, patient convenience, and faster performance.

The coronary artery calcium score (CAC) is a relatively new modality for cardiac risk estimation and stratification (Third Report of the National Cholesterol Education Program (NCEP) [3, 4]. In the last decade, several studies showed that CAC is a valuable risk marker as it is directly related to atherosclerotic plaque burden and independently predicts severe cardiac events in patients with known CAD [5] or all-cause mortality [6].

Current multi-slice computed tomography (MSCT) scanners provide promising results in the assessment of coronary artery disease (CAD), but some segments are not evaluative because of motion artifacts or severe vessel wall calcification.

MATERIALS AND METHODS

This study was done at the National Ribat hospital- Omer Sawi complex, Royal scan Diagnostic Centers and other Sudanese hospitals- Khartoum Sudan during the period from 2016 to 2018.

Subjects

Patients with different clinical symptoms , under went to multi slices CT study for coronary artery angiography and calcium scoring test by using CT. 135 patients (73 males and 62females) their ages ranged (18-80 mean 56) years were enrolled in the study. Informed consent was obtained from the patients and they signed a separate form.

Equipment used

CT machines images were conducted using 64-128 slices. The scan parameter (0.5mm, 120 KV, 300-500 MA). Image type original \primary \axial .scan option helical CT. Body part examined Chest .Patient position supine scout view AP\LAT. Slice thickness 0.5 mm. Injection rate (4-7 ml/s). Protocol name coronary cardiac CT. No gantry detector tilt. X ray tube current 430 focal sot 1.6\1.4 group pixel spacing.

METHODS

Technique used

Initial screening: Patient preparation and instruction should be performed by a qualified person when the procedure is scheduled.

Patient takes one capsule of beta blocker one day before the exam one at night and the last one in the day of the exam morning. Patient fasting at least 6 hours before the exam patient must to stop smoking and drinking tea and coffee before the exam we must to see the RFT test and blood pressure. Insure that the cannula size and position should be adequate for the high flow rate of power injector bolus intravenous administration of contrast and accordance with the individual facility policy and also the ECG tools in right side give good instruction to the patient. The patient is in supine position feet first. Two views were taken AP and LAT localize the area of the study then we done calcium scoring test firstly then CCTA the amount of contrast are about 70-100 ml with flow rate (4-7 ml/s), followed by a second injection of smaller volume of saline.

Data collection and analyzed

Well training and experienced CT technologists' radiologists and physician knowledgeable in CT and radiation exposure and cardiac anatomy and pathology. All patient images were evaluated by expert radiologist reporting on calcium scoring and other pathology. The data was collected using data sheet which contained the patient name age weight sex diagnosis and the feature then we takes the images to the radiologist for diagnosis all the data were analyzed using SPSS program the result were displayed as below.

Characterization of diseases

Coronary artery atherosclerosis plaque was characterized into the following three types based on the CT attenuation: calcified plaques indicate plaques with high density, noncalcified plaques refer to plaques having lower density compared with the contrast-enhanced vessel lumen, mixed plaques indicate plaques with non-calcified and calcified elements within a single plaque, or within a segment of the coronary artery .CAC was measured by chest computed tomography (CT) using multi-detector CT system. The amount of calcium was quantified by using the Agatston scoring method which divided in to minimal mild moderate and excessive score.

Aorta calcification Ventricular aneurysm pericardial effusion also characterize into minimal mild moderate and excessive appearance.

Fig-1: A contrast-enhanced CT of the coronary arteries, with excellent visualization of severs stenosis and rupture for Female 63 years old

The severity of stenosis also divided into mild moderate and severe. Also the degree of infarction divided in to minimal mild moderate and excessive score. Aortic aneurysm characterize as a Dilation of aorta more than 1.5 times.

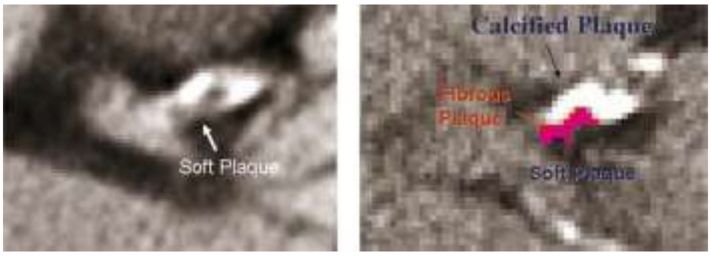

Fig-2a: contrast-enhanced (left image) for male patient 54 years old and non-contrast study (right image) of the left main and proximal left anterior descending for female patient 58 years old. The soft plaque is visible (dark region, representing fat density) with calcified plaque (white regions). A computer program can be applied) to the individual pixels to measure lower density (fat density, pink squares), intermediate density (red squares, fibrous density) and high density (white squares, calcified plaque).This can theoretically quantitate the volume of soft plaque, fibrous plaque and calcified plaque in any given CT image

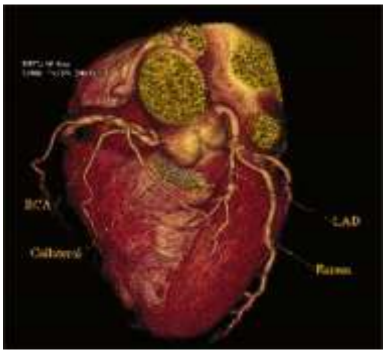

Fig-3A: contrast-enhanced CT for male patient 50 years of the coronary arteries, with excellent visualization of a high-grade stenosis in the mid-portion of the left anterior descending (LAD). A large collateral vessel is seen from the right coronary artery (RCA), but this is quite rare, as usually the collaterals are too small to be well seen on cardiac CT.A large ramus intermediacy is well visualized, and the dominant RCA is present. This is but one view of many that can be visualized with cardiac CT, allowing for near-complete visualizations of the coronary tree

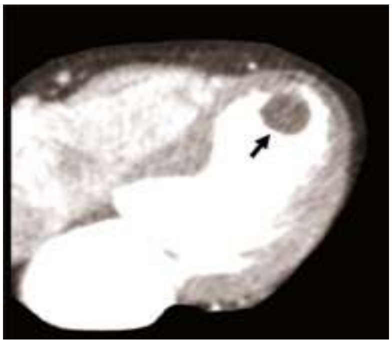

Fig-4: male 65 years old apical thrombus. This left ventricular thrombus (black arrow) demonstrates a large thrombus in the left ventricle

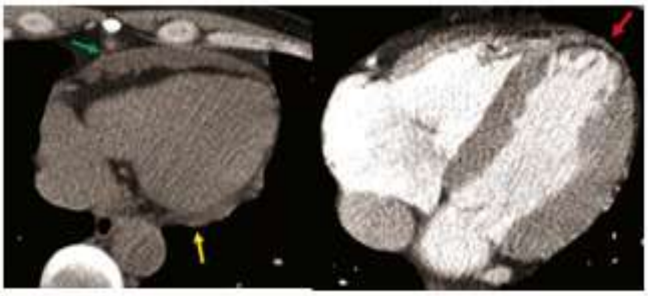

Fig-5: female 72 years old pericardial effusion

Table-1: frequency distribution of sex

Sex	Frequency	Percent	Valid Percent	Cumulative Percent
Female	62	45.9	45.9	45.9
Male	73	54.1	54.1	100.0
Total	135	100.0	100.0	

Table-2: frequency distribution of age group

Weight	Frequency	Percent	Valid Percent	Cumulative Percent
40-55 kg	3	2.2	2.2	2.2
56-70 kg	58	43.0	43.0	45.2
71-85kg	55	40.7	40.7	85.9
86-100 kg	19	14.1	14.1	100.0
Total	135	100.0	100.0	
	Min=40, max=100, means=73.50, Std. Deviation =10.18			

Table-3: frequency distribution of weight

Age group	Frequency	Percent	Valid Percent	Cumulative Percent
16-26 years	2	1.5	1.5	1.5
27-37 years	9	6.7	6.7	8.1
38-48 years	19	14.1	14.1	22.2
49-59 years	48	35.6	35.6	57.8
60-70 years	43	31.9	31.9	89.6
71-80 years	14	10.4	10.4	100.0
Total	135	100.0	100.0	
Min=18,max=80,mean= 56.60, std. Deviation =11.66				

Table-4: frequency distribution of diagnosis

Diagnosis	Frequency	Percent	Valid Percent	Cumulative Percent
Aorta calcification	2	1.5	1.5	1.5
Aortic aneurysm	6	4.4	4.4	5.9
Atherosclerosis	8	5.9	5.9	11.9
Ca score 0 normal	5	3.7	3.7	15.6
Coronary stenosis	30	22.2	22.2	37.8
Coronary stenosis and rupture	3	2.2	2.2	40.0
Extensive evidence ca score 1500	1	.7	.7	40.7
Extensive evidence ca score 1900	1	.7	.7	41.5
Extensive evidence ca score 2000	2	1.5	1.5	43.0
Extensive evidence Ca score 450	2	1.5	1.5	44.4
Extensive evidence Ca score 470	2	1.5	1.5	45.9
Extensive evidence Ca score 480	1	.7	.7	46.7
Infarction	5	3.7	3.7	50.4
Mild evidence ca score 28	1	.7	.7	51.1
Mild evidence ca score 70	1	.7	.7	51.9
Minimal evidence ca score 4	1	.7	.7	52.6
Moderate evidence ca score 178	1	.7	.7	53.3
Moderate evidence ca score 196	3	2.2	2.2	55.6
Moderate evidence ca score 200	2	1.5	1.5	57.0
Moderate evidence ca score 232	1	.7	.7	57.8
Moderate evidence ca score 243	6	4.4	4.4	62.2
Moderate evidence ca score 253	2	1.5	1.5	63.7
Pericardial effusion	5	3.7	3.7	67.4
Ventricular aneurysm	5	3.7	3.7	71.1
Normal	39	28.9	28.9	100.0
Total	135	100.0	100.0	

Table-5: frequency distribution of features

Feature	Frequency	Percent	Valid Percent	Cumulative Percent
Calcified	5	3.7	3.7	3.7
Dilation of aorta more than 1.5 times	5	3.7	3.7	7.4
Excessive	2	1.5	1.5	8.9
Extensive calcium	9	6.7	6.7	15.6
Mild	14	10.4	10.4	25.9
Mild calcium	2	1.5	1.5	27.4
Minimal	5	3.7	3.7	31.1
Minimal calcium	1	.7	.7	31.9
Mixed	1	.7	.7	32.6
Moderate	23	17.0	17.0	49.6
Moderate calcium	15	11.1	11.1	60.7
Non calcified	2	1.5	1.5	62.2
Normal	39	28.9	28.9	91.1
Normal calcium	5	3.7	3.7	94.8
Severe	7	5.2	5.2	100.0
Total	135	100.0	100.0	

Table-6: frequency distribution of side of coronary stenosis

Side of coronary stenosis	Frequency	Percent	Valid Percent	Cumulative Percent
Right	13	9.6	39.4	39.4
Left	20	14.8	60.6	100.0
Total	33	24.4	100.0	
Side of coronary stenosis	Frequency	Percent	Valid Percent	Cumulative Percent

Table-7: frequency distribution of branches which affected by coronary stenosis

Branches of CA affected	Frequency	Percent	Valid Percent	Cumulative Percent
One	16	11.9	48.5	48.5
Two	16	11.9	48.5	97.0
Three	1	.7	3.0	100.0
Total	33	24.4	100.0	

Table-8: Cross tabulation sex and diagnosis

Diagnosis	Sex		Total
	Female	Male	
Aorta calcification	1	1	2
Aortic aneurysm	1	5	6
Atherosclerosis	4	4	8
Ca score 0 normal	2	3	5
Coronary stenosis	12	18	30
Coronary stenosis and rupture	3	0	3
Extensive evidence Ca score 450	2	0	2
Extensive evidence Ca score 470	0	2	2
Extensive evidence Ca score 480	0	1	1
Extensive evidence ca score 1500	0	1	1
Extensive evidence ca score 1900	1	0	1
Extensive evidence ca score 2000	0	2	2
Infarction	2	3	5
Mild evidence ca score 28	1	0	1
Mild evidence ca score 70	0	1	1
Minimal evidence ca score 4	0	1	1
Moderate evidence ca score 178	1	0	1
Moderate evidence ca score 196	1	2	3
Moderate evidence ca score 200	1	1	2
Moderate evidence ca score 232	0	1	1
Moderate evidence ca score 243	3	3	6
Moderate evidence ca score 253	1	1	2
Normal	20	19	39
Pericardial effusion	2	3	5
Ventricular aneurysm	4	1	5
Total	62	73	135
P value = 0.527			

Table-9: cross tabulation age and diagnosis

Diagnosis	Age						Total
	16-26 years	27-37 years	38-48 years	49-59 years	60-70 years	71-80 years	
Aorta calcification	0	0	1	1	0	0	2
Aortic aneurysm	0	1	0	1	3	1	6
Atherosclerosis	0	1	1	5	1	0	8
Ca score 0 normal	0	0	0	1	3	1	5
Coronary stenosis	0	1	5	9	11	4	30
Coronary stenosis and rupture	0	0	0	1	2	0	3
Extensive evidence Ca score 450	0	0	0	1	1	0	2
Extensive evidence Ca score 470	0	0	0	0	2	0	2
Extensive evidence Ca score 480	0	0	1	0	0	0	1
Extensive evidence ca score 1500	0	0	0	1	0	0	1
Extensive evidence ca score 1900	0	0	0	1	0	0	1
Extensive evidence ca score 2000	0	0	1	1	0	0	2
Infarction	0	0	0	2	2	1	5
Mild evidence ca score 28	0	0	0	1	0	0	1
Mild evidence ca score 70	0	0	0	1	0	0	1
Minimal evidence ca score 4	0	0	1	0	0	0	1
Moderate evidence ca score 178	0	0	0	1	0	0	1
Moderate evidence ca score 196	0	0	1	1	1	0	3
Moderate evidence ca score 200	0	0	0	1	0	1	2
Moderate evidence ca score 232	0	0	0	1	0	0	1
Moderate evidence ca score 243	0	0	0	4	0	2	6
Moderate evidence ca score 253	0	1	0	0	1	0	2
Normal	2	5	8	9	13	2	39
Pericardial effusion	0	0	0	2	2	1	5
Ventricular aneurysm	0	0	0	3	1	1	5
Total	2	9	19	48	43	14	135
P value = 0.994							

Table-10: cross tabulation branches and side of CA stenosis

Side	Branches			Total
	One	Two	Three	
Right	10	3	0	13
Left	6	13	1	20
Total	16	16	1	33
P value =0.029				

Table-11: cross tabulation weight and diagnosis

Diagnosis	Weight				Total
	40-55 kg	56-70 kg	71-85kg	86-100 kg	
Aorta calcification	0	2	0	0	2
Aortic aneurysm	0	2	3	1	6
Atherosclerosis	0	4	2	2	8
Ca score 0 normal	0	1	4	0	5
Coronary stenosis	0	15	12	3	30
Coronary stenosis and rupture	0	1	1	1	3
Extensive evidence Ca score 450	0	0	2	0	2
Extensive evidence Ca score 470	0	0	2	0	2
Extensive evidence Ca score 480	0	0	1	0	1
Extensive evidence ca score 1500	0	0	0	1	1
Extensive evidence ca score 1900	0	0	1	0	1
Extensive evidence ca score 2000	0	1	1	0	2
Infarction	0	3	2	0	5
Mild evidence ca score 28	0	0	0	1	1
Mild evidence ca score 70	0	0	0	1	1
Minimal evidence ca score 4	0	1	0	0	1
Moderate evidence ca score 178	0	0	1	0	1
Moderate evidence ca score 196	0	0	3	0	3
Moderate evidence ca score 200	0	1	1	0	2
Moderate evidence ca score 232	0	0	1	0	1
Moderate evidence ca score 243	0	2	4	0	6
Moderate evidence ca score 253	0	2	0	0	2
Normal	3	21	10	5	39
Pericardial effusion	0	2	1	2	5
Ventricular aneurysm	0	0	3	2	5
Total	3	58	55	19	135
P value = 0.572					

DISCUSSION

Multi-slice CT angiography represents one of the most exciting technological revolutions in cardiac imaging and it has been increasingly used in the diagnosis of coronary artery disease. Rapid improvements in multi-slice CT scanners over the last decade have allowed this technique to become a potentially effective alternative to invasive coronary angiography in patients with suspected coronary artery disease. High diagnostic value has been achieved with multi-slice CT angiography with use of 64- and more slice CT scanners. In addition, multi-slice CT angiography shows accurate detection and analysis of coronary calcium, characterization of coronary plaques, as well as prediction of the disease progression and major cardiac events. Thus, patients can benefit from multi-slice CT angiography that provides a rapid and accurate diagnosis while avoiding unnecessary invasive coronary angiography procedures. In this study there were 135 patients with different complain done CA CT 39 of them was normal (Table 4). The result showed accurate detection and analysis of coronary calcium, plaques, as well as prediction of the disease progression and major cardiac events (Table 10).The composition of atherosclerotic plaques in the coronary arteries displays substantial variability and is associated with the likelihood for rupture and downstream ischemic events. Accurate identification and quantification of coronary plaque components on CT is challenging because of the limited temporal, spatial, and contrast resolutions of current scanners. Nonetheless, CT may provide valuable information that has potential for characterization of coronary plaques. For example, the extent of calcification can be determined, lipid-rich lesions can be separated from more fibrous ones, and positive remodeling can be identified .17in this study we had 8 patient had atherosclerotic plaques 5 of them were calcified 2were non calcified and only one was mixed (Tables 4 ,5).

Data from Greenland *et al*. demonstrated that intermediate-risk patients with an elevated coronary artery calcium (CAC) score (intermediate FRS and CAC score >300) had an annual hard event rate of 2.8%, or a 10-year rate of 28%, and thus would be considered high risk. The best estimates of the relative risk (RR) from this study indicated that a CAC score >300 had a hazard ratio (HR) of about 4 compared with a score of 0 (Table8, 9, 11). This would mean that the estimated risk in the intermediate-risk patient with a CAC score of 0 might be reduced by at least 2-fold while the risk of a person with a CAC score of 300+ would be increased by about 2-fold. Thus, the person with a high CAC score and intermediate FRS is now reclassified as high risk [7]. In the present study the prevalence of the ca score excessive 9 mild 2 minimal 1 moderate 15 normal 5 total of 37(Table5).

This study was performed to determine the diagnostic role of 64-slice multi-slice computed tomography (MSCT) in the detection of coronary artery disease (CAD).

Although based on a small number of patients, results showed that the left coronary artery undergoes dimensional changes due to atherosclerosis (Table 6); it is widely acknowledged that coronary plaques play a critical role in the pathogenesis of acute coronary syndromes due to local thrombus formation caused by plaque rupture or erosion, therefore, plaque composition rather than the degree of luminal narrowing may be predictive of the patient's risk for further coronary events [8].

In the present study left coronary artery diseases were more common than right coronary artery anomalies. This is in agreement with the results of one series [9, 10] in disagreement with results of other studies [11, 12] (Table 6).

Extensively calcified lesions most likely represent atherosclerosis at later stages of remodeling and may reflect more stable lesions [20]. Therefore, in the presence of coronary plaques, especially calcified plaques, coronary artery undergoes dimensional changes due to alternation process, resulting in corresponding diameter differences between the normal and diseased coronary arteries. Results from this study are consistent with other reports regarding the distribution and morphology of coronary plaques [13-16].

Atherosclerotic plaques were commonly located at the LAD, particularly close to the ostium of LAD, whereas the left main stem and the LCx were less frequently affected. This could be used as guidance for analysis of possible effects of the hemodynamic on the local characteristics and distribution of plaques [17].

In this study male to female ratio was 54.1 to 45.9 which agree with [18,10] (Table 1). The higher spatial resolution of CT allows visualization of coronary arteries both with and without contrast enhancement. The ability to see the coronary arteries on anon-contrast study depends upon the fat surrounding the artery (of lower density, thus more black on images), providing a natural contrast between the myocardium and the pericardial artery. Usually, the entire course of each coronary artery is visible on non-enhanced scans. The major exception is bridging, when the coronary artery delves into the myocardium and cannot bed is distinguished without contrast. The distinction of blood and soft tissue (such as the left ventricle, where there is no air or fat to act as a natural contrast agent) requires injection MSCT is a highly accurate diagnostic modality for congenital heart diseases, obviating the need for invasive modalities. Beside its noninvasive nature, the advantage of MSCT over the angiography is its ability to provide detailed anatomical information about the heart, vessels, lungs and intra-abdominal organs[19]. The LAD artery is the most commonly occluded of the coronary arteries. It provides the major blood supply to the interventricular septum, and thus bundle branches of the conducting system. Hence, blockage of this artery due to coronary artery disease can lead to impairment or death (infarction) of the conducting system. The result is a "block" of impulse conduction between the atria and the Ventricles known as "right/left bundle branch block [20].

CONCLUSION

With the development of new modalities, such as multi detector ECG gated cardiac MSCT, noninvasive imaging of small mobile structures, such as coronary arteries, has become possible. Because of the high prevalence, morbidity, mortality, and enormous socioeconomic burden of coronary artery disease, noninvasive detection of significant coronary artery stenosis has been the driving force behind the development of this technology. As the technology evolves, cardiac CT will become readily available, making interpretation a necessary clinical ability. In the future diagnostic non- invasive anatomic and functional imaging need to be evaluated in large patient populations to establish their efficacy, safety, and cost effectiveness. Importantly, these investigations should result in the development of comprehensive guidelines on the use of CTA in clinical practice as well. Moreover, the combined use of these techniques may enhance the assessment of the presence and extent of CAD.

Although further work is required to determine the prognostic utility of MSCT and to clarify its precise clinical role, the currently available data suggest that it will play an increasing role in the evaluation of patients with known or suspected CAD.

For consistency successful imaging, interpretation, and diagnosis, a clear understanding of the techniques capabilities and limitations, and an appreciation of the details of patient selection, patient preparation, scan acquisition, and image reconstruction are required.

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