College of Health and Medical Technologies
Department of Radiology Technologies
Computed Tomography

CT of the Chest:
- Cardiac CT
- High Resoultion CT

4 th stage

LECTUER 9

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MSc Radiographic Imaging

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The **CT chest (non-contrast) protocol** serves as an outline for the acquisition of a chest CT without the use of an intravenous contrast medium.

Indications

* findings on chest radiographs or other imaging modalities
* screening and follow up of pulmonary nodules or metastases
lung cancer screening
* COVID19
* pulmonary infections
*chronic dyspnea
*pulmonary emphysema
* chest trauma (if no vascular injury is suspected)
* foreign bodies
* contraindications to iodinated contrast
* thoracic interventions (e.g. CT-guided
biopsy, drainage, percutaneous lung tumor ablation)


Emotion 16
SP 1: -229.9
SP 2: -557.4
LEN: 327.5
GT: 0.0
FoV: 401
CE: -28 / 0
10cm
kV 130
mA 25

تصوير الصدر

Technique

patient position

supine position, thorax centered within the gantry

both arms elevated

tube voltage

≤120 kVp

tube current

as suggested by the automated current adjustment mode

scout

mid-abdomen to below the lesser trochanter

scan extent

from the lung apices to the bottom

might vary depending on the indication

scan geometry

field of view (FOV): 300 mm

slice thickness: ≤0.625 mm, interval: ≤0.5 mm

reconstruction kernel: bone window (e.g. I70), soft tissue window (e.g. I40)

respiration phase

single breath-hold: inspiration

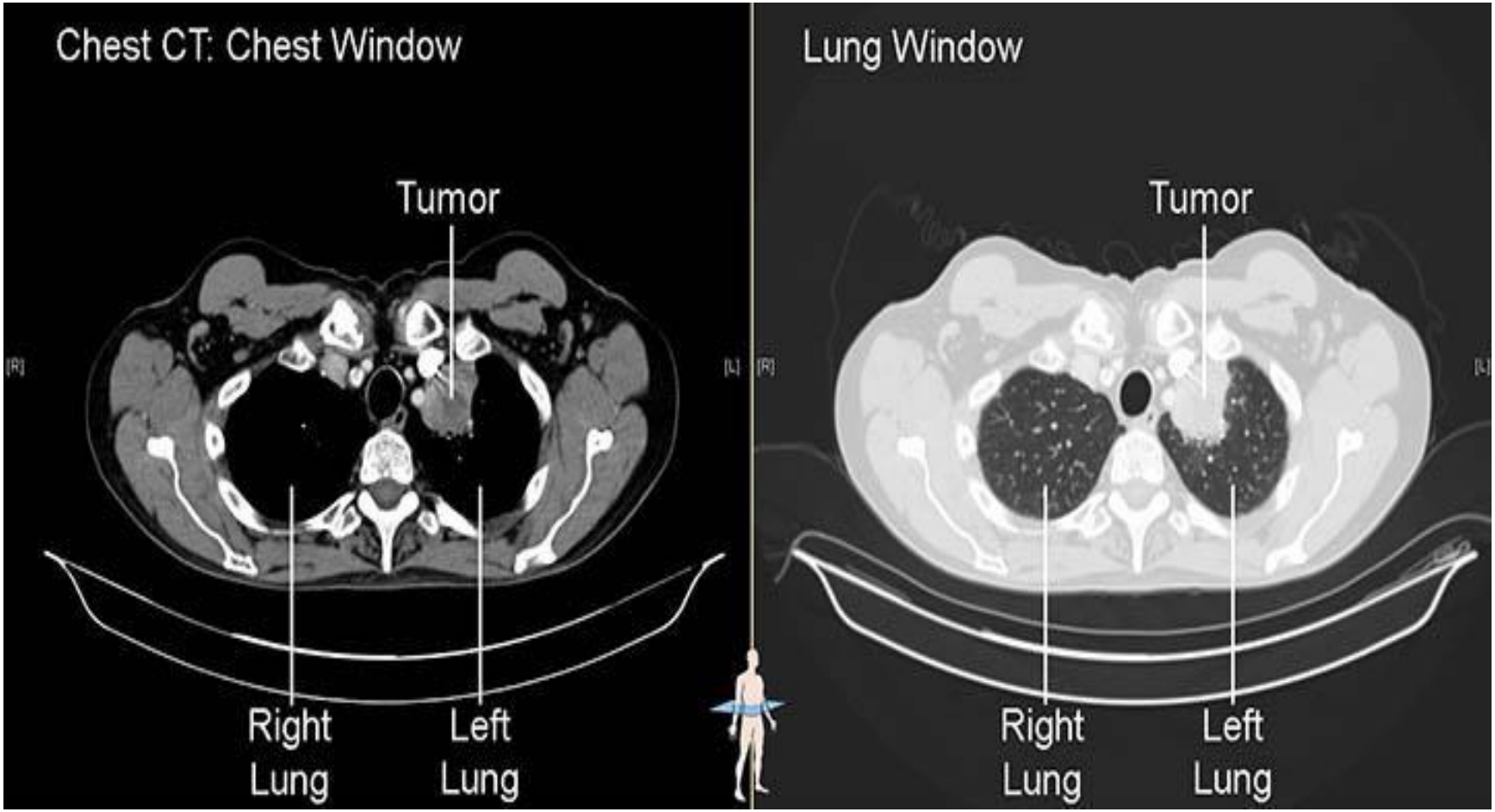
multiplanar reconstructions

axial images, coronal images, sagittal images

slice thickness: lung ≤3 mm, soft tissue ≤3 mm, bone ≤2 mm overlap 50%

maximum intensity projections

slice thickness: 8-10 mm, overlap 50%

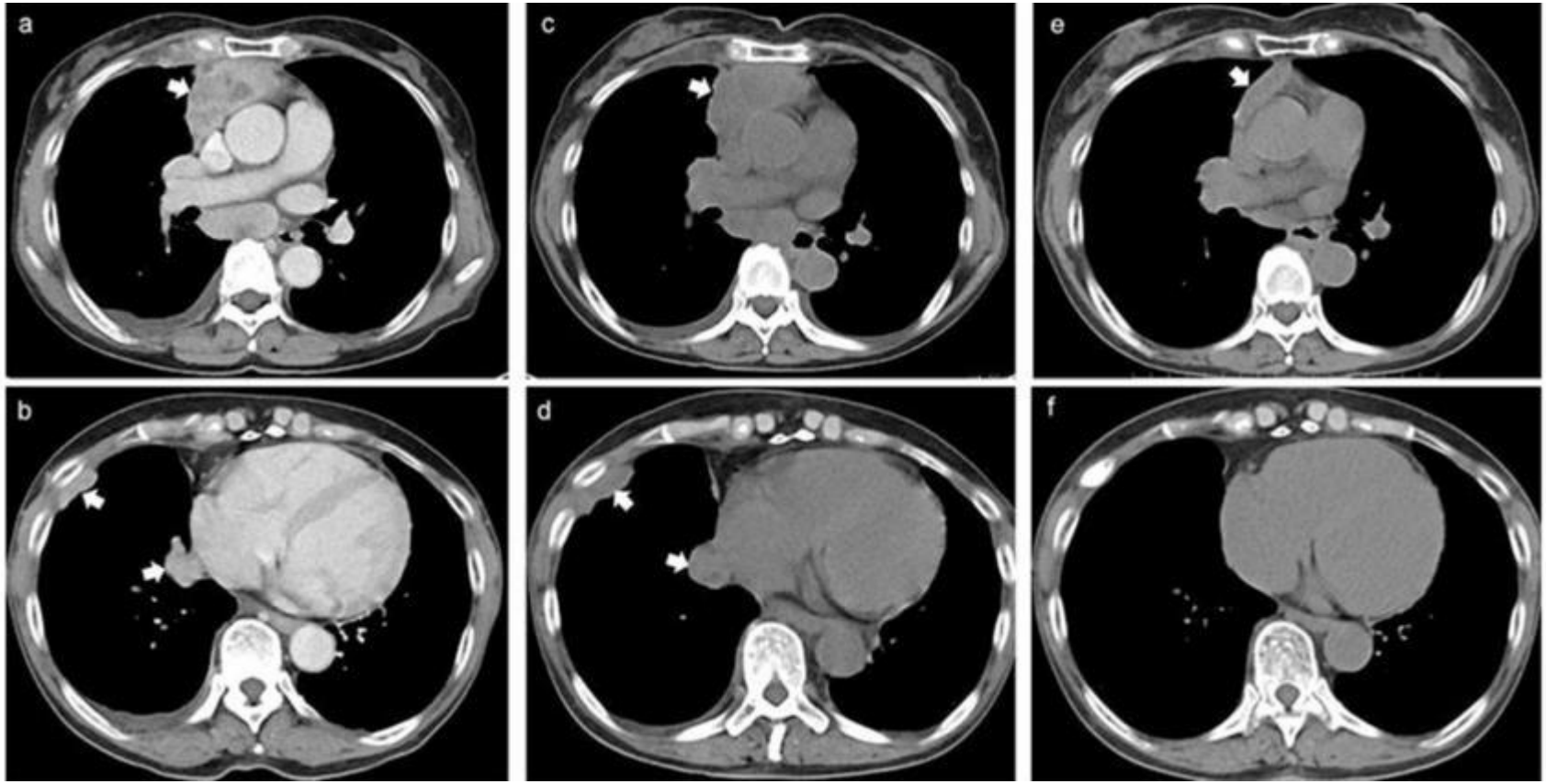

Chest CT: Chest Window
Tumor
[R]
[L]
Right Lung
Left Lung
Lung Window
Tumor
[R]
[L]
Right Lung
Left Lung

Role of contrast CT chest imaging

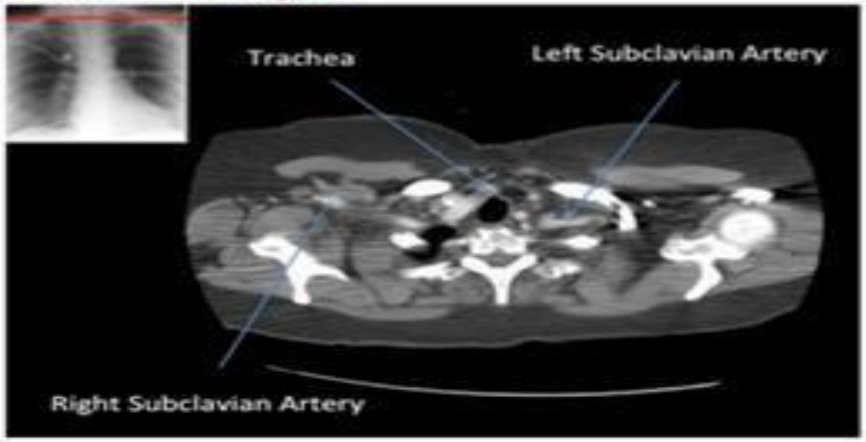
I.V. contrast media enables the confident identification of vascular anatomy, aids delineation of adjacent non-vascular structures, and improves both the detection and characterization of pathological lesions. It is used to aid assessment of mediastinal structures, vascular structures, chronic pleural disease, lung masses, and differentiation of parenchyma from the pleura or pleural collections. Contrast may also be administered orally for assessment of the oesophagus.

I.V. contrast is administered via a high-pressure syringe pump at between 3 and 6 ml s.

contrast CT chest imaging

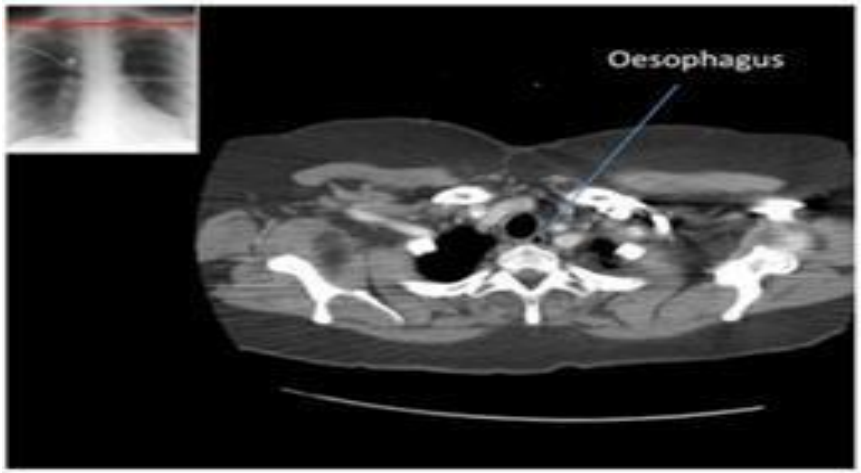


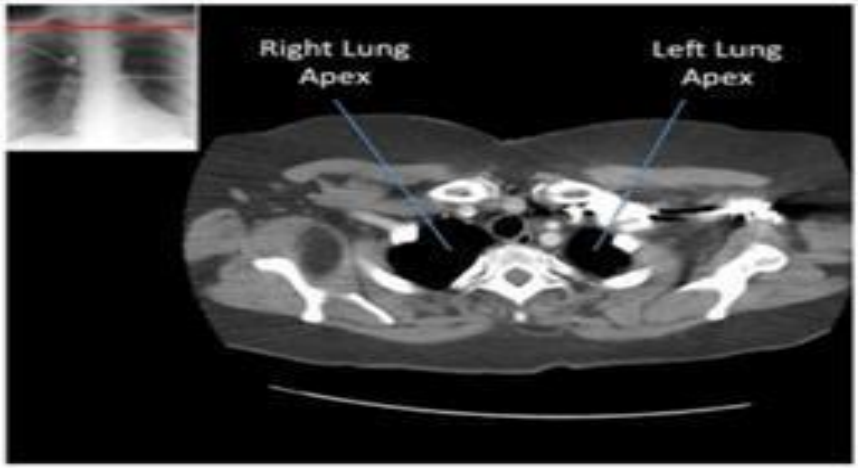
Great Vessels Region

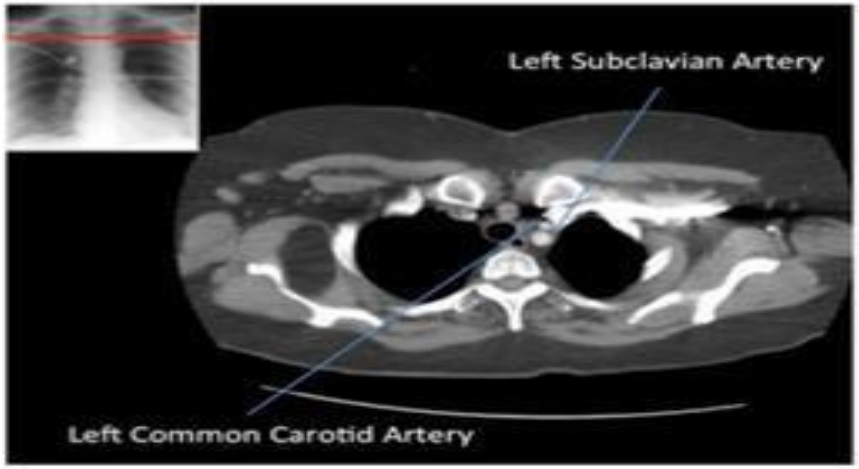


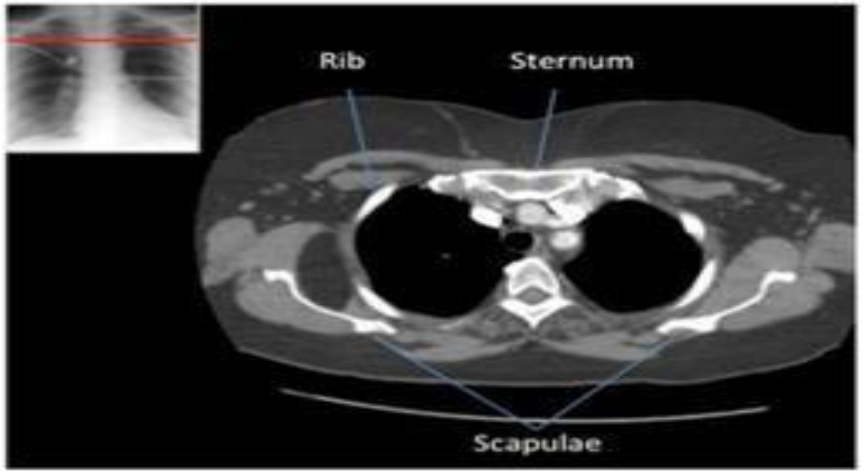
Located within this region are the:

-trachea
-oesophagus
-subclavian vessels
-carotid vessels
-lung apices
-Boney structures

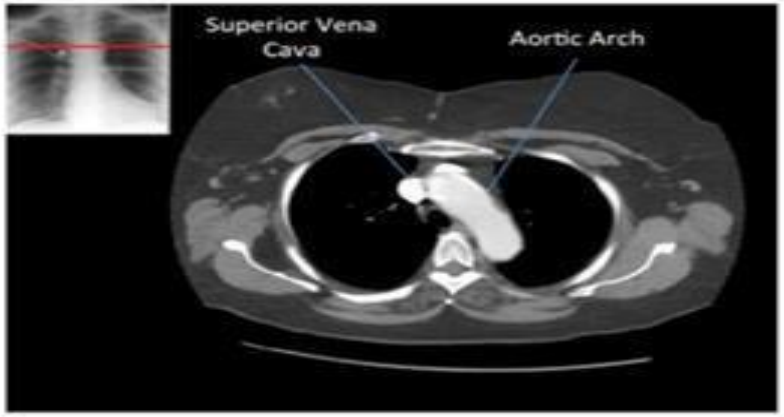








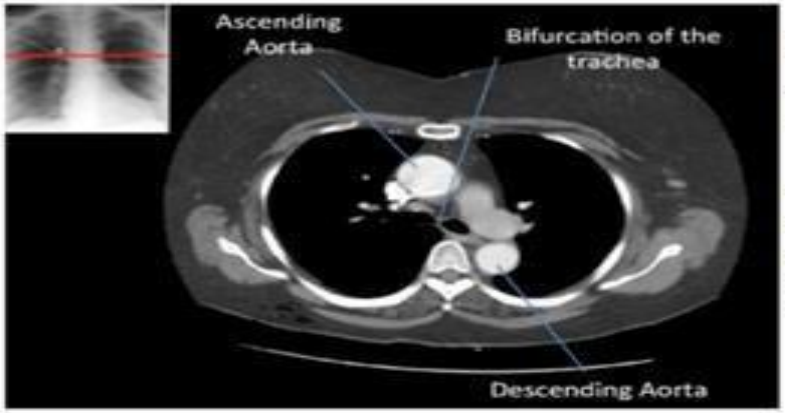
Aortic Arch Region



Located within this region are:

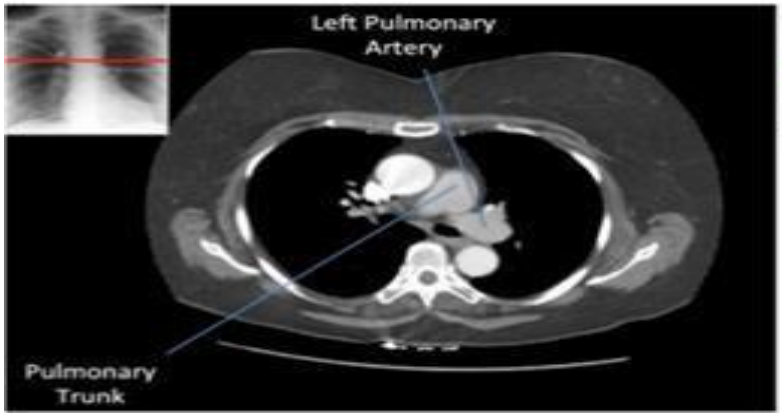
- *Superior Vena Cava*
- *Aortic Arch*

Carina and Pulmonary Vessel Region



Located within this region are the:

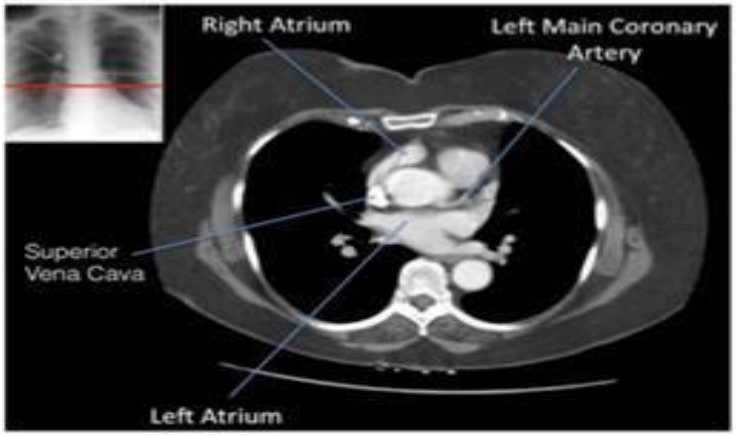
- *Ascending and Descending Aorta*
- *Bifurcation of the trachea*
- *Aortic Arch*
- *Pulmonary Arteries*
- *Pulmonary Trunk*

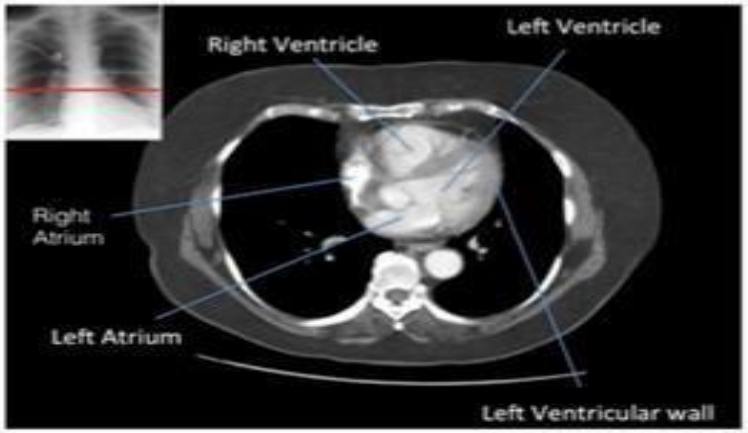


Atria Region

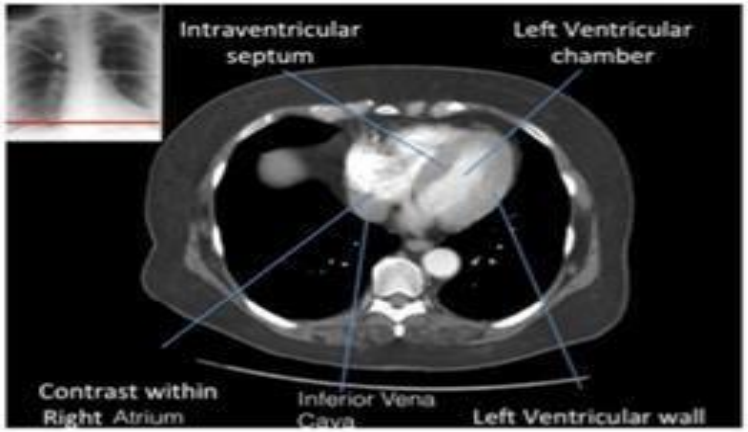
Located within this region are the

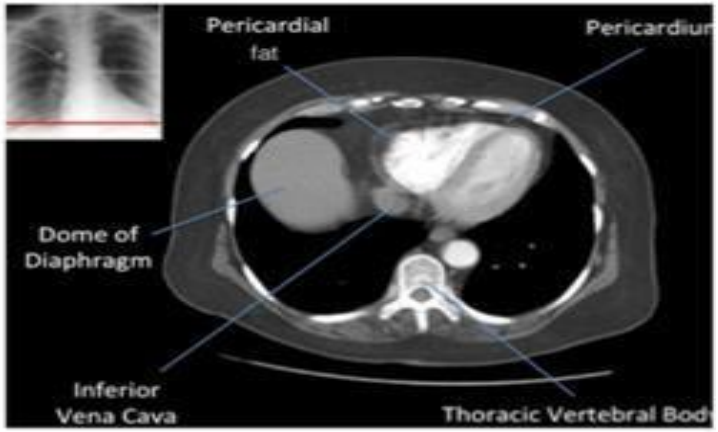
- *Atria*
- *Coronary Arteries*
- *The superficial aspects of the Ventricles*





Ventricular Region





Located within this region are the

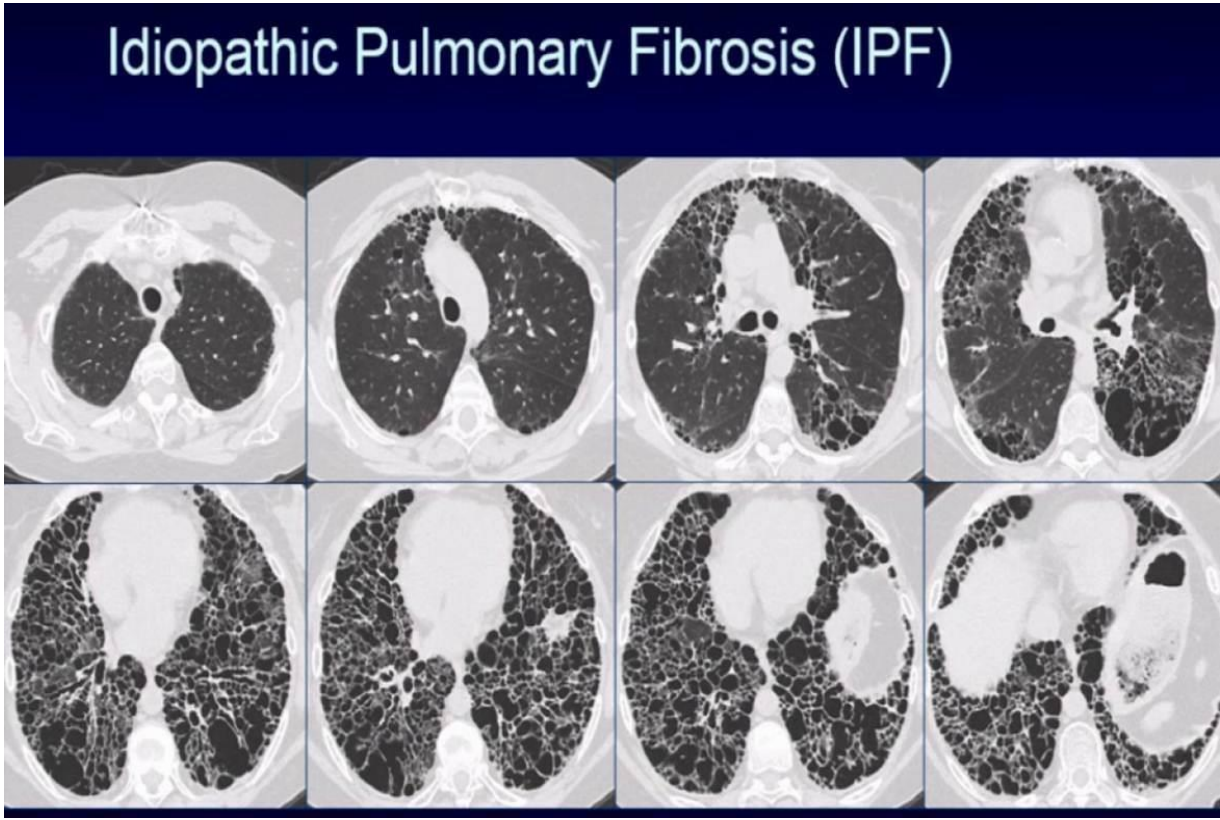
- *Ventricles*
- *Interventricular Septum*
- *Pericardium*
- *Pericardial Sac*
- *Dome of Diaphragm*

HRCT

High-resolution CT (HRCT) of the chest, also referred to as **HRCT chest** or **HRCT of the lungs**, refers to a CT technique in which thin-slice chest images are obtained and post- processed in a high-spatial-frequency reconstruction algorithm. This technique obtains images with perfect lung detail, which are ideal for the assessment of diffuse interstitial lung disease. A full HRCT protocol usually includes additional acquisitions:

Expiratory images

prone images



Indications

HRCT is particularly useful in the assessment of diffuse lung conditions involving the interstitium such as:

interstitial lung disease

cystic lung disease

small airways disease

pulmonary micronodules

bronchiectasis

HRCT may be used to evaluate extent of disease, monitor treatment response, and select biopsy sites in the setting of diffuse interstitial lung disease.

Fundamental technical protocols

slice thickness: 0.625-1.25 mm

scan time: 0.5-1 second

kV: 120

mAs: 100-200

collimation: 1.5-3 mm

matrix size: 768 x 768 or the largest available

FOV: 35 cm

reconstruction algorithm: high spatial frequency

window: lung window

patient position: supine (routinely) or prone (if suspected ILD)

level of inspiration: full inspiration (routinely recommended) expiratory HRCT scans in patients with obstructive lung diseases

Reducing radiation dose

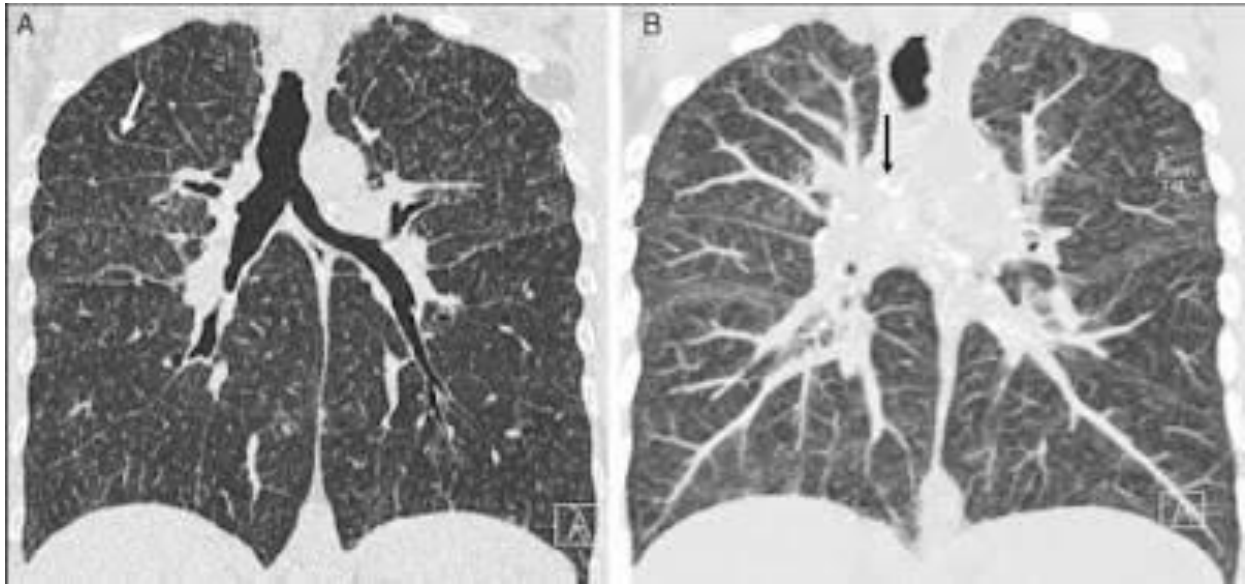
Lower dose CT protocols may be used in follow-up scans of known or younger patients at the price of slightly lower image quality. Most patients undergo many studies for surveillance of their disease; hence, this can result in significant radiation dose reduction.

Methods usually applied for that include:

lower mAs (~40 mA)

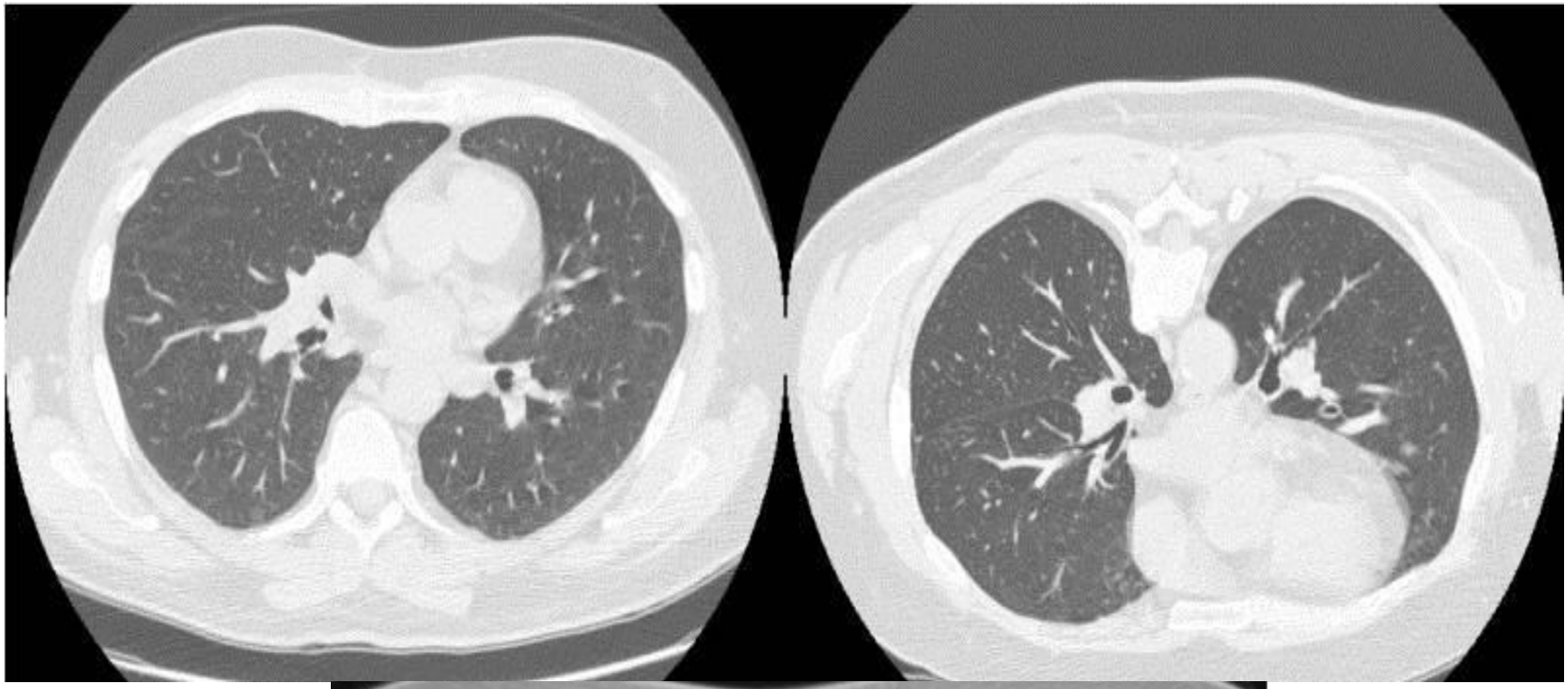
sequential spaced acquisition

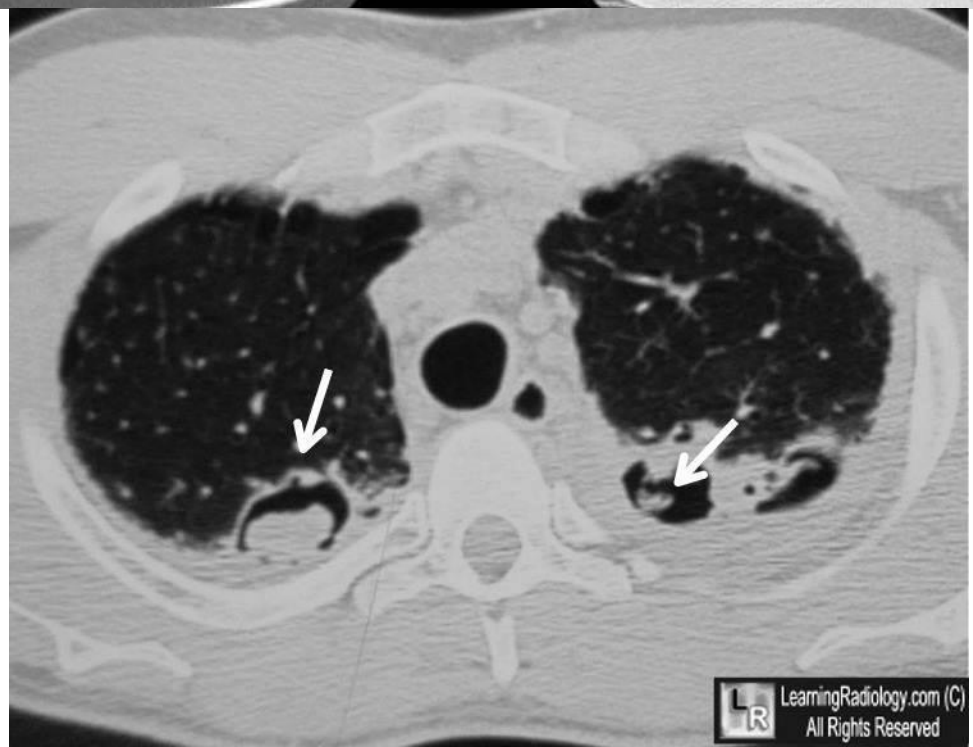
commonly applied for the additional expiratory and prone scans some institutions also apply this technique for the full inspiration scan in patients that undergo imaging follow-up



HRCT chest: prone images

- **Prone high-resolution CT (HRCT) chest** corresponds to an additional CT acquisition performed as part of an HRCT chest protocol. It represents a scan performed with the patient in a prone position and images obtained in full inspiration.
- This additional imaging is particularly useful for detecting subtle or early interstitial lung disease (ILD). The rationality behind it is to differentiate it from dependent lung atelectasis, which commonly presents as subpleural densities or lines.
- Prone HRCT can also be useful in assessing potential fungal balls (aspergillomas) as they are mobile and are dependent in both supine and prone positions .

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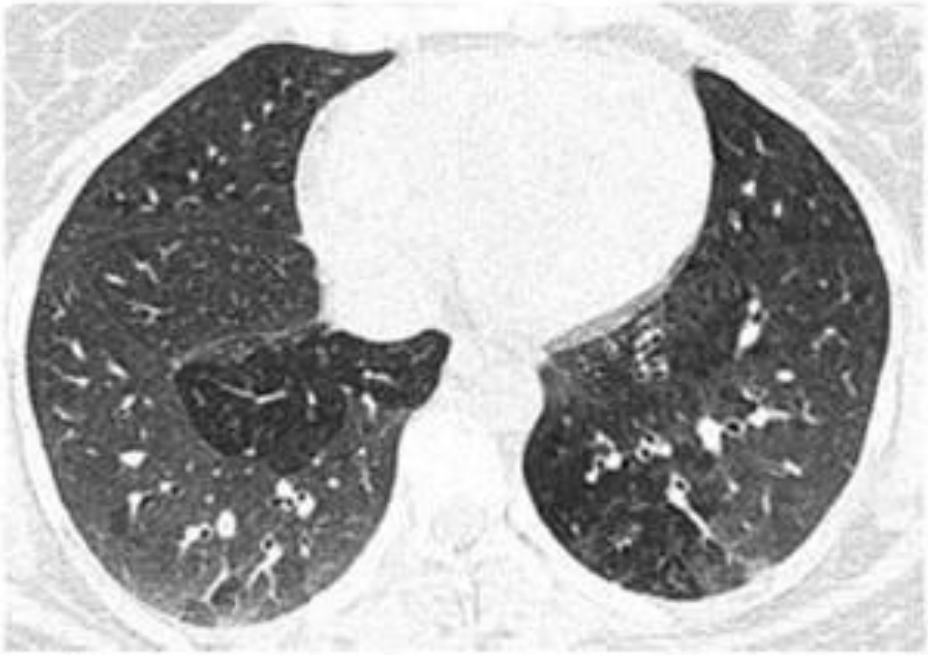
HRCT chest: expiration (technique)

- **Expiratory high-resolution CT (HRCT) imaging** corresponds to an additional CT acquisition performed as part of the HRCT chest protocol. It represents a scan performed with the patient on supine and images obtained at the end-expiration.
- It is a useful method for detecting small airways obstructive lung disease, in which the air remains trapped in the pulmonary lobules even after the expiration (air-trapping). This technique may also be applied in the assessment for tracheobronchomalacia

Inspiratory

Expiratory



Purpose

The aim of this technique is to highlight areas of air trapping, since during expiration the rest of the lung parenchyma will show an increase in density (as the amount of air in the alveoli decreases). These areas of air trapping will appear radiolucent.

Technique

patient position

supine with their arms above their head

scout

apices to diaphragm

scan extent

apices to diaphragm

scan direction

caudocranial

contrast injection considerations

no contrast

scan delay

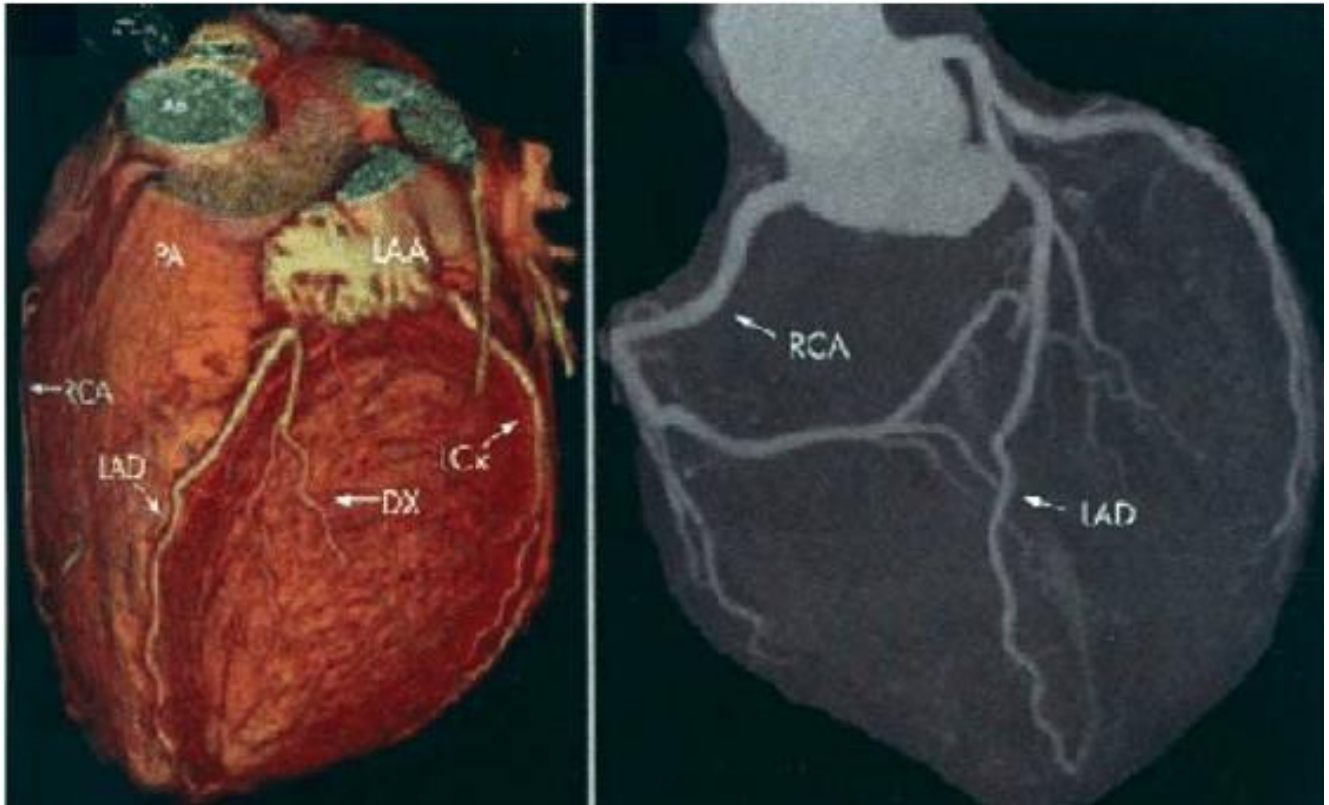
minimal

respiration phase

scan performed on expiration

CARDIACT ,CORONARY & PULMONARY ANGIOGRAM

The **coronary CT angiography** or **cardiac CT angiogram** protocol is the most common dedicated cardiac CT examination and is a non-invasive tool for the evaluation of the coronary arteries.



INDICATIONS

Classical indications for a coronary CT angiography are the Following :

- **-congenital coronary artery anomalies**
- **preoperative assessment**
- **coronary artery disease to rule out significant luminal stenosis& coronary atherosclerotic plaque evaluation**
- **surgical or interventional planning of chronic coronary occlusions**
- **patency assessment of coronary bypass grafts in symptomatic individuals**
- **unclear findings after invasive coronary angiography (ICA)**
- **visualization of cardiac veins**

CONTRAINDICATIONS

- acute ST-elevation myocardial infarction
- screening of asymptomatic patients with low risk of CAD
- factors leading to potentially non-diagnostic scans:

inability to cooperate (e.g. breath-hold instructions, arm elevation etc.)

markedly irregular rhythm (e.g. atrial fibrillation)

body mass index >39 kg/m^2

- contraindications against iodinated contrast media
- pregnancy
- Contraindications to ß-blockers & nitrates
- systolic blood pressure ≤90 mmHg

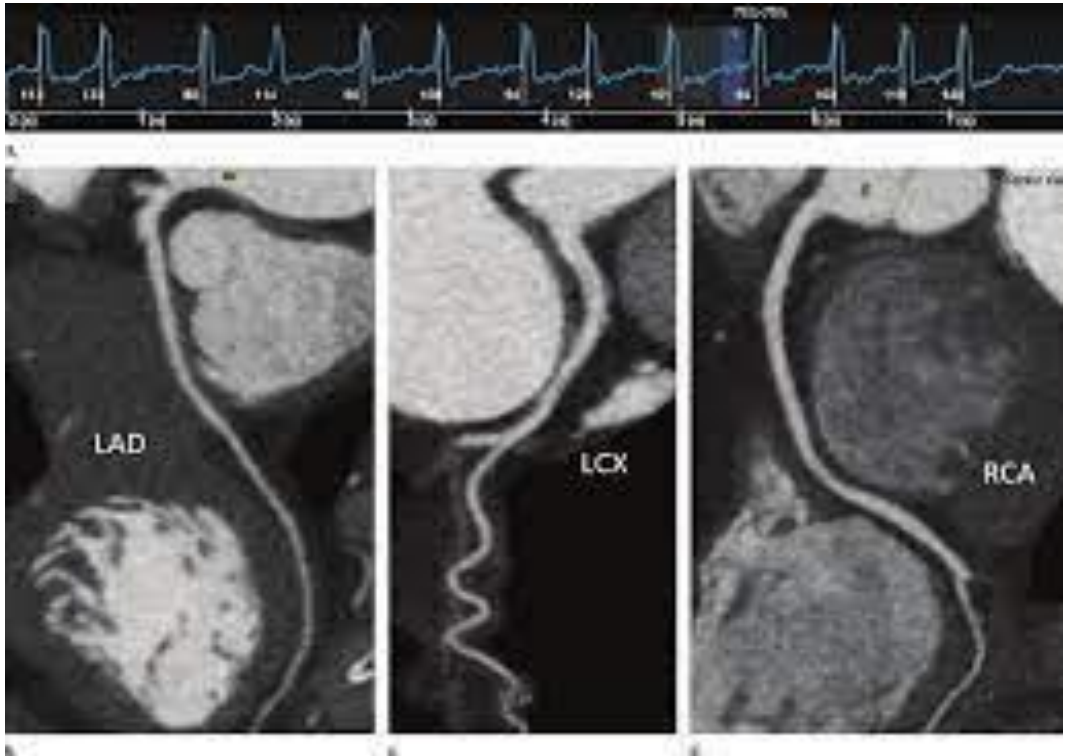
TECHNICAL REQUIREMENTS

Minimal technical requirements for a coronary CT angiogram are the following :

-64-slice scanner

-detector element width ≤0.625 mm

-option of cardiac CT and ECG-gated triggering



PATIENT PREPARATION

- Checking indications, contraindications, explanation of the examination and obtaining informed consent is obvious as in other CT examinations.
- Beyond that patient preparation for cardiac CTA includes the following :
- -checking contraindications for nitrates and ß-blocker
- -patients should take their cardiac medications as usual
- -no food 3-4 hours before the scan
- -no caffeine for 12 hours
- -instruction how to breathe
- -electrocardiogram signal need to be acquired
- -heart rate control

PREMEDICATION

Premedication comprises the following :

-check heart rate and blood pressure before administration of medications

-administration of nitrates (400-800 µg of sublingual nitroglycerin e.g. 1-2 sprays)

-administration of ß-blocker (to target pulse of ≤60 bpm)

---e.g. metoprolol 50-100 mg one hour before the exam

---e.g. metoprolol 5mg iv followed of monitoring for 5 min repeatedly up to 15-20 mg

Technique

patient position

supine with both arms above their head (as comfortable as possible)

ECG placement

acquisition

prospective ECG-gated high-pitch acquisition

is a high pitch helical acquisition of the heart that is able to capture a single phase of the cardiac cycle, a dual-source scanner is required to perform it.

prospective ECG-gated acquisition

images are obtained in a sequential or strict axial manner during a pre-defined phase of the cardiac cycle (R-R interval) without table movement at the time of data acquisition.

retrospective ECG-gated acquisition

In a retrospective ECG-gated cardiac CT imaging data is constantly obtained throughout the whole cardiac cycle while the patient moves slowly through the scanner.

tube potential

100 kVp if patient's weight ≤100kg or BMI <30kg/m^2

tube current

use automated current adjustment mode

scout

pulmonary apices to below the heart

scan extent

just below tracheal bifurcation to below the heart

scan direction

craniocaudal

ECG considerations

check scan can occur in the agreed-upon portion of the R-R interval within the patient's current heart rate

typically in mid-diastole in lower heart rates <70 bpm

mid-diastole to end-systole at higher heart rates 70-80 bpm

contrast injection considerations

contrast agents with high iodine concentrations (270-400 mg iodine/mL)

monitoring: ascending aorta

contrast volume

triphasic scan (for longer bolus)

50-70 mL contrast media at 5-7 mL/s

10-20 mL contrast media with 30-40 mL saline at 5-7 mL/s

30-40 mL saline chaser at 3-5 mL/s

biphasic scan (standard contrast injection)

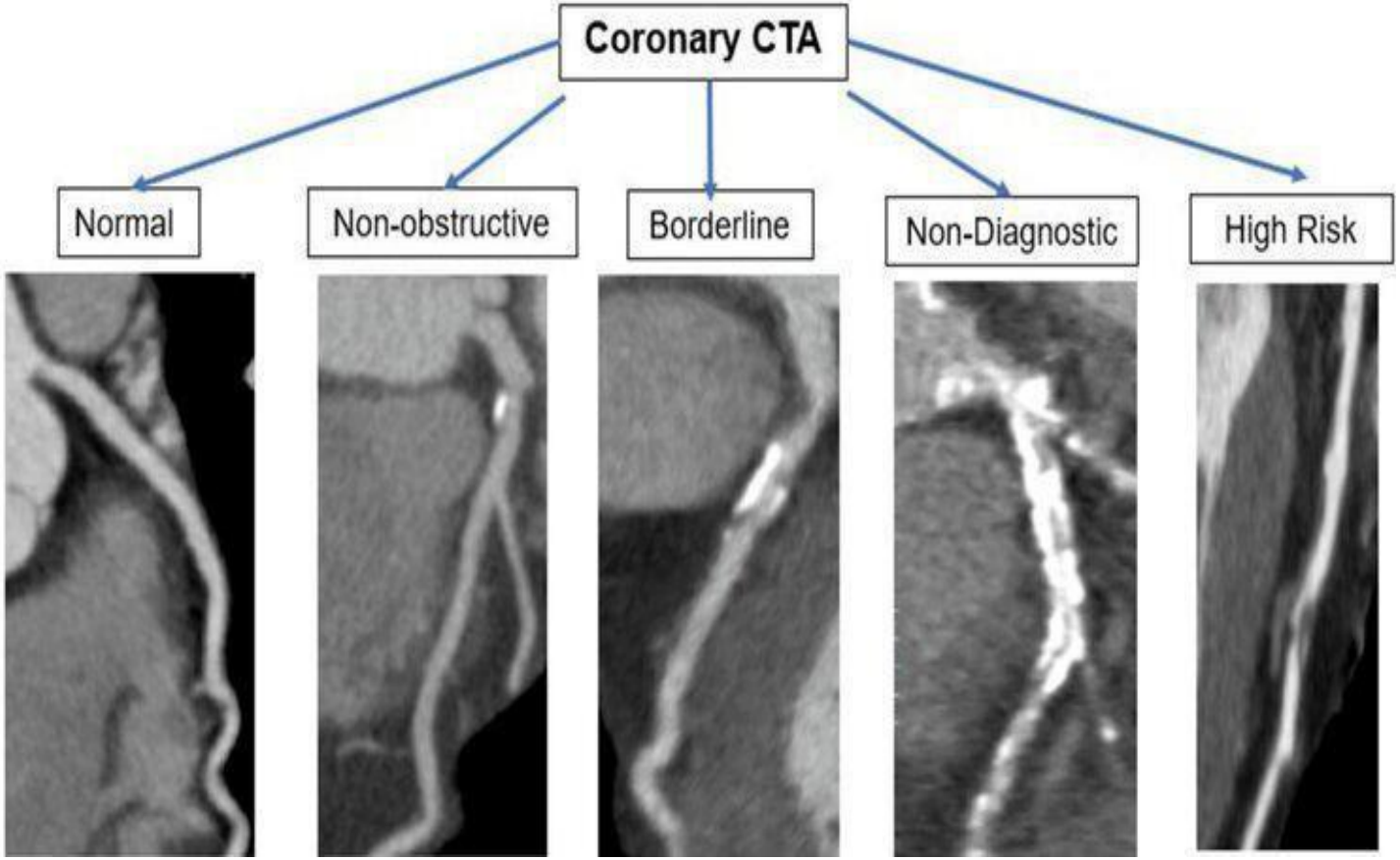
50-80 mL contrast media at 5-7 mL/s

40-50 mL saline chaser at 5-7 mL/s

respiration phase

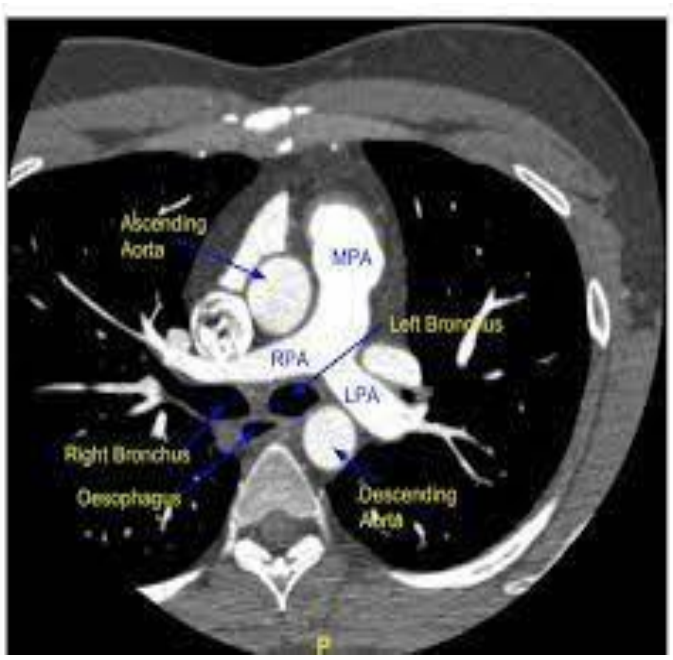
inspiration

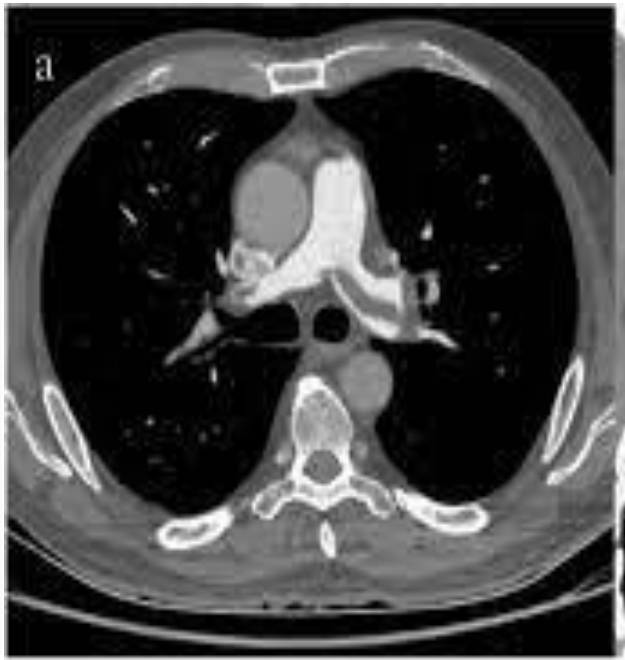
for breath-hold consistency, a medium-sized breath is easier to reproduce throughout the examination compared to sharp deep breaths


Coronary CTA
Normal
Non-obstructive
Borderline
Non-Diagnostic
High Risk

CT PULMONARY ANGIOGRAM

The **computed tomography pulmonary angiogram** (**CTPA**) is a commonly performed diagnostic examination to exclude pulmonary emboli.





Indications

Suspected pulmonary embolism: acute or chronic.

Purpose

This technique is based on the detection of filling defects in the pulmonary arterial vasculature, so acquisition at the right time is of vital importance. The study is considered optimal when the pulmonary arteries are opacified and the aorta is not. Late acquisition will make it difficult to differentiate between pulmonary arterial and pulmonary venous branches.

Contraindications

previous severe reactions to iodinated contrast

Technique

Bolus tracking

patient position

supine with their arms above their head

scout

apices to diaphragm

scan extent

apices to diaphragm

scan direction

caudocranial

inspiration

contrast injection considerations

monitoring slice (region of interest) below the carina at the level of the pulmonary trunk with an ROI on the pulmonary artery

threshold

100 HU

volume

60 mL of non-ionic contrast with a 100 mL saline chaser at 4.5/5 mL/s

scan delay

minimal scan delay

respiration phase

inspiration

THANK YOU