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**Q1: What are the major differences between CT scan and MRI Scan?**

**ANS: Differences between CT scan and MRI Scan:**

[CT scans](https://www.healthline.com/health/ct-scan) and MRIs are both used to capture images within your body.

The biggest difference is that MRIs (magnetic resonance imaging) use radio waves and CT (computed tomography) scans use [X-rays](https://www.healthline.com/health/x-ray).

While both are relatively low risk, there are differences that may make each one a better option depending on the circumstances.

**What are MRIs?**

Using radio waves and magnets, MRIs are used to view objects inside your body.

They’re frequently used to diagnose issues with your:

1. joints
2. [brain](https://www.healthline.com/health/head-mri)
3. wrists
4. ankles
5. [breasts](https://www.healthline.com/health/chest-mri)
6. [heart](https://www.healthline.com/health/heart-mri)
7. blood vessels

A constant magnetic field and radio frequencies bounce off of the fat and water molecules in your body. Radio waves are transmitted to a receiver in the machine which is translated into an image of the body that can be used to diagnose issues.

An MRI is a loud machine. Typically, you’ll be offered earplugs or headphones to make the noise more bearable.

You’ll also be asked to lie still while the MRI is taking place.

**What are CT scans?**

A CT scan is a form of X-raying that involves a large X-ray machine. CT scans are sometimes called CAT scans.

A CT scan is typically used for:

1. bone fractures
2. tumors
3. cancer monitoring
4. finding internal bleeding

During a CT scan, you’ll be asked to lie down on a table. The table then moves through the CT scan to take cross-sectional pictures inside your body.

**CT scan vs. MRI**

CT scans are more widely used than MRIs and are typically less expensive.

MRIs, however, are thought to be superior in regards to the detail of the image. The most notable difference is that CT scans use X-rays while MRIs do not.

Other differences between MRI and CT scans include their risks and benefits:

**Risks**

Both CT scans and MRIs pose some risks when used. The risks are based on the type of imaging as well as how the imaging is performed.

**CT scan risks include:**

1. harm to unborn babies
2. a very small dose of radiation
3. a potential reaction to the use of dyes

**MRI risks include:**

1. possible reactions to metals due to magnets
2. loud noises from the machine causing hearing issues
3. increase in body temperature during long MRIs
4. [claustrophobia](https://www.healthline.com/health/claustrophobia)

You should consult a doctor prior to an MRI if you have implants including:

1. artificial joints
2. [eye implants](https://www.healthline.com/health/prosthetic-eye)
3. [an IUD](https://www.healthline.com/health/birth-control-iud)
4. a [pacemaker](https://www.healthline.com/health/heart-pacemaker)

**Benefits**

Both MRIs and CT scans can view internal body structures. However, a CT scan is faster and can provide pictures of tissues, organs, and skeletal structure.

An MRI is highly adept at capturing images that help doctors determine if there are abnormal tissues within the body. MRIs are more detailed in their images.

**Choosing between an MRI and CT scan**

Most likely, your doctor will give you a recommendation based on your symptoms whether you should get an MRI or CT scan.

If you need a more detailed image of your soft tissue, ligaments, or organs, your doctor will commonly suggest an MRI.

Such cases include:

* [herniated disks](https://www.healthline.com/health/herniated-disk)
* torn ligaments
* soft tissue issues

If you need a general image of an area like your internal organs, or due to a fracture or head trauma, a CT scan will commonly be recommended.

**Q2: Which 3D reformation techniques are commonly used in musculoskeletal CT imaging? Explain them.**

**ANS: 3D reformations:** Surface Rendering **(SR)**

Maximum intensity projection **(MIP)**

 Minimum-intensity projection **(MinIP)**

 Volume Rendering **(VR)**

**Curved planar reformation:**

Curved planar reformation **(CPR)** allows images to be created along the centerline of tubular organs (e.g., vascular structures, common bile duct, ureters)

By this technique the entire tubular structure is displayed within a single image

**Surface rendering:**

* In surface rendering (SR), also known as shaded-surface
 display (SSD), the voxels located on the edge of a structure are used to show the outline or outside shell of the structure.
* In most forms of SR the images are created by comparing the intensity of each voxel in the data set to some predetermined threshold CT value. The software will include or exclude the voxel depending on whether its CT number is above or below the threshold and use this information to create a surface of an object.
* A threshold value of radio-density is chosen by operator (e.g. a level that corresponds to a bone).
* A threshold value is set using, edge detection image processing alogrithms.
* From this a 3D model is reconstructed and displayed on screen.

**SR:** Manipulating the predefined threshold value can dramatically change the appearance of displayed structures, allowing multiple models to be reconstructed.

* The interior structure of each element is not visible in this mode.
* SR remains a useful technique for orthopedic imaging.

**Maximum intensity projection MIP:**

* The MIP examines each voxel and selects only the voxel with the highest value for inclusion in the displayed image. The rest of the voxels are ignored.
* This method tends to display bone and contrast-filled structures; lower-attenuation structures are not well visualized.

 It is very useful in angiographic studies.

**Minimum intensity projection MinIP:**

* MinIP involves selecting the voxel with the minimum
value from the line for display.
* MinIP is mainly used to diagnose **lung diseases** with computed tomography scans where the attenuation values are reduced (for examplebronchectasis and emphysema).
* Another application is for assessing the **bile tree and pancreatic duct** which as compared to the surrounding tissue is hypo-attenuating (especially after intravenous contrast media administration).

**Volume Rendering:**

* VR is a **3D semitransparent** representation of the imaged
structure.
* An advantage of VR compared with other 3D techniques is that **all voxels** contribute to the image. This allows VR images to display multiple tissues and show their relationships to one another.

 The pixels in the final VR image can be assigned a **color, brightness, and degree of opacity**. For example normal soft tissue can be assigned high transparency , contrasted vessels slight opaqueness, and bone strong
opaqueness

**Volume Rendering**

* VR allows the user a high degree of interactivity. The user can easily change the look of the VR by changing variables such as the color scale, applied lighting, opacity values, and window settings.
* The image can be rotated and viewed from any angle.
* By varying opacity and window width and level functions, anatomy can be displayed or made invisible.
* This allows the user to quickly classify structures based on their attenuation. For example, adjusting the window settings can often remove the soft tissue from the VR display so that the contrast-enhanced vascular structures can be seen, without the need for time-consuming data set editing.

**Endoluminal imaging**

* Endoluminal imaging is a form of VR designed to reveal the inside of the lumen of a structure..
* The technique can be used to image areas that are amenable to endoscopic evaluation, such as the lumen of the bronchial tree **(virtual bronchoscopy),** lumina of the larger blood vessels, the inside surface of the colon **(virtual colonoscopy or CT colonography) ,** and
the mucosa of the paranasal sinuses.
* Endoluminal imaging technique is also called **virtual endoscopy, virtual bronchoscopy, and virtual colonoscopy.**

**Region-of-Interest Editing:**

* The process of **selectively removing or isolating** information from the data set is referred to as region-of-interest editing or **segmentation.**
* The purpose is to better demonstrate the areas of interest by removing obscuring structures.
* 3D software allows this editing to be in a manual, automatic, or semiautomatic fashion.

**Q3: What is the function of “sure start” in CT imaging?**

**ANS: surestart:**

Planning the scan delay using the surestart bolus tracking tool planning the scan delay using the surestart bolus tracking tool is illustrated in .the selected scan plane just above the origin the of coronary arteries is chosen to start the scan at the optimal time by monitoring the arrival of the contrast bolus in region of interest (ROI) placed in the descending aorta .important landmarks in this plane are the sternum anteriorly and the descending aorta posteriorly. Also seen in this plane are segment of the pulmonary trunk and portsan of the anterolateral chest wall. The ROI in the descending aorta is used to monior the increase in Hounsfield units (HU) after initiation of contrast injection.

## The scan delay after contrast injection can be determined in one of the two ways (1) by injection of a test bolus to determine the patient’s individual circulation time and optimize the spiral scan parameters accordingly or (2) bolus tracking with automatic triggering of the scan once a predefined Hounsfield threshold has The use of state-of-the-art helical CT scanners allows for ultra-fast examination of larger regions of the body. Due to the short examination time, optimum utilization of the intravenous contrast medium bolus is of extreme importance. The Sure Start function grants this in a very simple way.

**Q4: What are the major differences between single slice CT and Multislice CT?**

**ANS: single slice CT:**

Detector elements used in the CT system were introduced in Chapter 2. Until the 1990s all commercial scanners contained many detector elements aligned in a single row. The single-row design was used in both third- and-fourth generation systems. In third generation systems approximately 700 detector elements were arranged in an arc; fourth-generation systems used as many as 4,800 detectors in a single row arranged in a complete ring. In scanners with a single-detector row, each detector element is quite wide in the z direct (approximately 15 mm) and opening or closing the collimator controls the slice thickness by controlling the portion of the detector’s width that is exposed to the incoming x-rays. The width of the detectors (in the z axis) in a single-detector array places an upper limit on slice thickness. Opening the collimation beyond this point would do nothing to increase slice thickness, but would increase both the dose to the patient and the amount of scattered radiation. Therefore, in these systems the largest allowable slice thickness is less than the detector width, typically 10 mm. The radiation emitted from the collimated x-ray source in these systems is commonly referred to as a fan beam. Each gantry rotation produces data for a single slice. Calculating the area of patient anatomy to be covered during an examination with a single-detector row, axial scan method is a simple process of multiplying the slice increment selected by the number of slices acquired. If slices are contiguous the slice increment will be equal to the slice thickness. For example, an examination protocol of the abdomen calls for contiguous, 5-mm slices to be taken from the level of the diaphragms to the level of the iliac crest. In this case the collimator is opened to 5 mm, and the table is moved 5 mm after each gantry rotation. Using an AP localizer image to plan the study, 40 images would be required if the total z distance to be scanned is 200 mm (40 images × 5 mm). For the sake of illustration, if the 40 slices were to be acquired using a 5-mm slice thickness, but a 7-mm slice increment (skipping 2 mm of anatomy between each slice), then the total distance from ﬁrst slice to last would be 280 mm (40 images × 7 mm).on

**Multislice CT:**

Newer CT systems continue to use many detector elements situated in a row. However, they may contain from 4 to 64 parallel rows. In multidetector row (MDCT) scanners a single rotation can produce multiple slices. Therefore, MDCT provides longer and faster z axis coverage per gantry rotation. Additionally, many MDCT systems have increased the speed of gantry rotation, which further increases volume coverage per unit time. Slice thickness is determined by a combination of the x-ray beam width (controlled by the collimators) and the detector conﬁguration. The radiation emitted from the collimated x-ray source in these systems is commonly referred to as a cone beam. Multiple detector channels can be used for either axial or helical data acquisitions. Depending on the scanner manufacturer and the number of detector rows, the parallel rows may be of equal size, referred to as a uniform array, or they may be variable, with thinner rows centrally and wider rows peripherally .These variable-width detector thought of as dividing the detector into segments in the z axis. The size and number of segments used determine the slice thickness and number of slices that can be acquired simultaneously. Compared with SDCT, for a given slice thickness, this conﬁguration results in a fourfold increase in the volume of data acquired in a single rotation. Scanners with four data acquisition channels have more than four parallel rows of detectors. This allows for scanning with various slice thickness. For example, the General Electric Light speed QX/I (GE Healthcare, Milwaukee, WI) scanner system uses 16 detector rows, each 1.25 mm wide, arranged side-by-side along the z axis. These rows can be grouped in various combinations to generate four slices. Using one detector row for each slice will provide slices that are each 1.25 mm thick. Grouping two detector rows together will provide slices that are each 2.5 mm thick Combining three detector rows will result in slices that are each 3.75 mm thick. Using all the available 16 detectors in groups of four will result in a 5-mm slice thickness. Using the four-slice MDCT example above it is apparent that the slice thickness of an MDCT scanner is not determined solely by the degree of physical collimation of the x-ray beam as is the case with SDCT, but is also impacted by the width of the detectors in the slice thickness (z axis) dimension. The width of the slice is changed by combining different numbers of individual detector elements together. When combined, the electronic signals generated by adjacent detectors are summed. Although MDCT technology started with scanners that produced two or four slices per rotation, the detector designs quickly advanced, offering 16 thin slices, and then as many as 64 thin slices. Although the detector conﬁguration schemes vary with each permutation, with regards to slice thickness, the concept remains the same as with the earlier 4-slice models. That is, different combinations of detector elements can be combined to vary the slice thickness reconstructed. It is likely that future technical enhancements will continue this trend of an increasing number of detector channels placed in the z axis. Prototypes for 256-row detectors are currently being tested. The biggest advantage of the 256-row scanners will be their ability to image the heart, brain, and many other organs in a single rotation. As an interesting side note, MDCT designs were responsible for the demise of fourth-generation scanning systems. Fourth-generation systems contained a complete ring of detectors. To form a complete ring, many separate detector elements were required. As many as 4,800 detectors were necessary to form a single row. Should that design be expanded to a 64-slice MDCT, 307,200 detectors would have to be used. The expense associated with so many detectors made the fourth-generation design unfeasible for MDCT.

**Q5: What are general protocols for performing CT contrast studies?**

**ANS:** The purpose of these **CT protocol** pages is to provide a reference for radiology residents, fellows and technologists when prescribing a CT examination. This reference is meant to serve as a guideline for prescribing CT examinations, and should be modified as needed for a particular patient.

**CT contrast media:**

Iodinated contrastmedia are **contrast agents** that contain **iodine** atoms used for x-ray-based imaging modalities such as computedtomography (**CT**), although they are also used in fluoroscopy, angiography and venography, and even occasionally, plain radiography.

**The contrast material used in a CT scan:**

Iodine-based and Gadolinium-based. Iodine-based **contrast materials** injected into a vein (intravenously) are **used** to enhance x-ray and **CT** images. Gadolinium injected into a vein (intravenously) is **used** to enhance MR images.

 **Use contrast in a CT scan**

A special dye called **contrast** material is needed for some **CT scans** to help highlight the areas of your body being examined. The **contrast** material blocks X-rays and appears white on images, which can help emphasize blood vessels, intestines or other structures. **Contrast** material might be given to you: By mouth.

**CT Contrast Given Via Intravenous Injection**

"Intravenous" means that the contrast is injected into a vein using a small needle. Some imaging exams of the abdomen and gastrointestinal system use both the intravenous iodine and orally administered barium contrast for maximum sensitivity.

**Difference between oral and IV contrast:**

**IV contrast** is either gadolinium for MRI or iodinated contrast for CT. Rectal contrast like oral contrast is dilute iodinated contrast, but administered through a rectal tube.

**Side effects of contrast dye after a CT scan:**

Side effects of iodine contrast can include: skin rash or hives. Itching, headache.

Possible side effects of an abdominal CT scan

* Abdominal cramping.
* Diarrhea.
* Nausea or vomiting.
* Constipation.

**Side effects of oral contrast:**

Side effects of iodine contrast can include: skin rash or hives. Itching, headache.

Possible side effects of an abdominal CT scan

* Abdominal cramping.
* Diarrhea.
* Nausea or vomiting.
* Constipation.

**Side effects of iodine contrast:**

Iodine-based Contrast Materials

* Nausea and vomiting.
* Headache.
* Itching.
* Flushing.
* Mild skin rash or hives.

 **IV contrast stay in your body:**

With normal kidney function, most of the gadolinium is removed from your body in the urine within 24 hours. If you have acute renal failure or severe chronic kidney disease and receive a gadolinium-based contrast agent, there may be a very small risk of developing a rare condition.

**Contrast dye damage kidneys:**

CIN is a rare disorder and occurs when kidney problems are caused by the use of certain contrastdyes. About 2 percent of people receiving dyes can develop CIN. However, the risk for CIN can increase for people with diabetes, a history of heart and blood diseases, and chronic kidney disease (CKD).

**CT scan better with or without contrast:**

Please remove all piercings and leave all jewelry and valuables at home. CONTRAST MEDIA: **CT** scans are most frequently done with and without a contrast media. The contrast media improves the radiologist's ability to view the images of the inside of the body. Some patients should not have an iodine-based contrast media.