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Computed Tomography (CT) - Chest

Computed tomography (CT) of the chest uses special x-ray equipment to examine abnormalities found in other imaging tests and to help diagnose the cause of unexplained cough, shortness of breath, chest pain, fever and other chest symptoms. CT scanning is fast, painless, noninvasive and accurate. Because it is able to detect very small nodules in the lung, chest CT is especially effective for diagnosing lung cancer at its earliest, most curable stage.

Tell your doctor if there is a possibility you are pregnant and discuss any recent illnesses, medical conditions, medications you are taking, and allergies. You will be instructed not to eat or drink anything for a few hours beforehand. If you have a known allergy to contrast material, your doctor may prescribe medications to reduce the risk of an allergic reaction. These medications must be taken beginning 12 hours prior to your exam. Leave jewelry at home and wear loose, comfortable clothing. You may be asked to wear a gown.

What is CT Scanning of the Chest?

Computed tomography, more commonly known as a CT or CAT scan, is a diagnostic medical test that, like traditional x-rays, produces multiple images or pictures of the inside of the body.

The cross-sectional images generated during a CT scan can be reformatted in multiple planes, and can even generate three-dimensional images. These images can be viewed on a computer monitor, printed on film or transferred to a CD or DVD.

CT images of internal organs, bones, soft tissue and blood vessels provide greater detail than traditional x-rays, particularly of soft tissues and blood vessels.

Using a variety of techniques, including adjusting the radiation dose based on patient size and new software technology, the amount of radiation needed to perform a chest CT scan can be significantly reduced. A low-dose chest CT produces images of sufficient quality to detect many lung diseases and abnormalities using much less radiation than a conventional chest CT scan—in some cases lowering the

dose by 65 percent or more. Low dose chest CT is routinely used for evaluation of acquired and congenital lung abnormalities, such as pneumonia, interstitial lung disease or tumor evaluation. There is ongoing research to lower radiation doses even further. Your radiologist will decide the proper settings to be used for your scan depending on your medical problems and what information is needed from the CT scan. If your child is to have a CT scan, the proper low-dose pediatric settings should be used.

What are some common uses of the procedure?

Chest CT is used to:

- examine abnormalities found on conventional chest x-rays.
- help diagnose the causes of clinical signs or symptoms of disease of the chest, such as cough, shortness of breath, chest pain, or fever.
- detect and evaluate the extent of tumors that arise in the chest, or tumors that have spread there from other parts of the body.
- assess whether tumors are responding to treatment.
- help plan radiation therapy.
- evaluate injury to the chest, including the heart, blood vessels, lungs, ribs and spine.
- evaluate abnormalities of the chest found on fetal ultrasound examinations.

Chest CT can demonstrate various lung disorders, such as:

- benign and malignant tumors.
- pneumonia.
- tuberculosis.
- bronchiectasis, cystic fibrosis.
- inflammation or other diseases of the pleura (the covering of the lungs).
- interstitial and chronic lung disease.
- congenital abnormalities.

CT scanning has recently been approved for screening asymptomatic people who have smoked a significant amount of cigarettes by the Centers for Medicare and Medicaid Services. See the Lung Cancer Screening page for more information.

A CT angiogram (CTA) may be performed to evaluate the blood vessels (arteries and veins) in the chest. This involves the rapid injection of an iodine-containing fluid (contrast material) into a vein while obtaining CT images. See the CT Angiography (CTA) page for more information.

How should I prepare?

You should wear comfortable, loose-fitting clothing to your exam. You may be given a gown to wear during the procedure.

Metal objects, including jewelry, eyeglasses, dentures and hairpins, may affect the CT images and should be left at home or removed prior to your exam. You may also be asked to remove hearing aids and

removable dental work. Women will be asked to remove bras containing metal underwire. You may be asked to remove any piercings, if possible.

You will be asked not to eat or drink anything for a few hours beforehand, if contrast material will be used in your exam. You should inform your physician of all medications you are taking and if you have any allergies. If you have a known allergy to contrast material, or "dye," your doctor may prescribe medications (usually a steroid) to reduce the risk of an allergic reaction. These medications generally need to be taken 12 hours prior to administration of contrast material. To avoid unnecessary delays, contact your doctor before the exact time of your exam.

Also inform your doctor of any recent illnesses or other medical conditions and whether you have a history of heart disease, asthma, diabetes, kidney disease or thyroid problems. Any of these conditions may increase the risk of an unusual adverse effect.

Women should always inform their physician and the CT technologist if there is any possibility that they may be pregnant. See the Safety page for more information about pregnancy and x-rays.

What does the equipment look like?

The CT scanner is typically a large, box-like machine with a hole, or short tunnel, in the center. You will lie on a narrow examination table that slides into and out of this tunnel. Rotating around you, the x-ray tube and electronic x-ray detectors are located opposite each other in a ring, called a gantry. The computer workstation that processes the imaging information is located in a separate control room, where the technologist operates the scanner and monitors your examination in direct visual contact and usually with the ability to hear and talk to you with the use of a speaker and microphone.

How does the procedure work?

In many ways CT scanning works very much like other x-ray examinations. Different body parts absorb the x-rays in varying degrees. It is this crucial difference in absorption that allows the body parts to be distinguished from one another on an x-ray film or CT electronic image.

In a conventional x-ray exam, a small amount of radiation is aimed at and passes through the part of the body being examined, recording an image on a special electronic image recording plate. Bones appear white on the x-ray; soft tissue, such as organs like the heart or liver, shows up in shades of gray, and air appears black.

With CT scanning, numerous x-ray beams and a set of electronic x-ray detectors rotate around you, measuring the amount of radiation being absorbed throughout your body. Sometimes, the examination table will move during the scan, so that the x-ray beam follows a spiral path. A special computer program processes this large volume of data to create two-dimensional cross-sectional images of your body, which are then displayed on a monitor. CT imaging is sometimes compared to looking into a loaf of bread by cutting the loaf into thin slices. When the image slices are reassembled by computer software, the result is a very detailed multidimensional view of the body's interior.

Refinements in detector technology allow nearly all CT scanners to obtain multiple slices in a single rotation. These scanners, called multislice CT or multidetector CT, allow thinner slices to be obtained in a shorter period of time, resulting in more detail and additional view capabilities.

Modern CT scanners are so fast that they can scan through large sections of the body in just a few seconds, and even faster in small children. Such speed is beneficial for all patients but especially children, the elderly and critically ill, all of whom may have difficulty in remaining still, even for the brief time necessary to obtain images.
For children, the CT scanner technique will be adjusted to their size and the area of interest to reduce the radiation dose.

To produce high-quality scans at a lower radiation dose, low-dose CT scanning uses a variety of techniques, including:

- dose modulation, in which radiation dosage is continuously adjusted to the patient's size at each location as the patient moves through the scanner
- "noise management" software to filter out unnecessary data
- the use of shields (this method depends on the type of CT scanner being used)
- external shields made out of bismuth may be placed on the patient
- the x-ray tube may be turned off during part of its rotation
- lower peak voltage settings

Your radiologist will select the appropriate dose reduction method(s) to accomplish the lowest possible dose necessary to answer the clinical question at hand.

How is the procedure performed?

The technologist begins by positioning you on the CT examination table, usually lying flat on your back. Straps and pillows may be used to help you maintain the correct position and to help you remain still during the exam.

Many scanners are fast enough that children can be scanned without sedation. In special cases, sedation may be needed for children who cannot hold still. Motion will cause blurring of the images and degrade the quality of the examination the same way that it affects photographs.

If a contrast material is used, it will be injected into a vein shortly before scanning begins.

Next, the table will move quickly through the scanner to determine the correct starting position for the scans. Then, the table will move slowly through the machine as the actual CT scanning is performed. Depending on the type of CT scan, the machine may make several passes.

You may be asked to hold your breath during the scanning. Any motion, whether breathing or body movements, can lead to artifacts on the images. This loss of image quality can resemble the blurring seen on a photograph taken of a moving object.

When the examination is completed, you will be asked to wait until the technologist verifies that the images are of high enough quality for accurate interpretation.

The actual CT scanning takes less than 30 seconds and the entire process, including exam preparation, is usually completed within 30 minutes.

What will I experience during and after the procedure?

CT exams are generally painless, fast and easy. With multidetector CT, the amount of time that the patient needs to lie still is reduced.

Though the scanning itself causes no pain, there may be some discomfort from having to remain still for several minutes and with placement of an IV. If you have a hard time staying still, are very nervous or anxious or have chronic pain, you may find a CT exam to be stressful. The technologist or nurse, under the direction of a physician, may offer you some medication to help you tolerate the CT scanning procedure.

For exams (excluding head and neck) your head will remain outside the hole in the center of the scanner. The scanner is approximately 24 inches wide, therefore, your entire body will be "inside" the scanner at one time such as with MRI.

If an intravenous contrast material is used, you will feel a pin prick when the needle is inserted into your vein. You will likely have a warm, flushed sensation during the injection of the contrast materials and a metallic taste in your mouth that lasts for at most a minute or two. You may experience a sensation like you have to urinate; however, this is actually a contrast effect and subsides quickly.

When you enter the CT scanner, special light lines may be seen projected onto your body, and are used to ensure that you are properly positioned. With modern CT scanners, you will hear only slight buzzing, clicking and whirring sounds as the CT scanner's internal parts, not usually visible to you, revolve around you during the imaging process.

You will be alone in the exam room during the CT scan, unless there are special circumstances. For example, sometimes a parent wearing a lead shield may stay in the room with their child. However, the technologist will always be able to see, hear and speak with you through a built-in intercom system.

After a CT exam, the intravenous line used to inject the contrast material will be removed by the technologist, and the tiny hole made by the needle will be covered with a small dressing. You can return to your normal activities.

Who interprets the results and how do I get them?

A radiologist with expertise in supervising and interpreting radiology examinations will analyze the images and send an official report to your primary care physician or physician who referred you for the exam, who will discuss the results with you.

Follow-up examinations may be necessary. Your doctor will explain the exact reason why another exam is requested. Sometimes a follow-up exam is done because a potential abnormality needs further evaluation with additional views or a special imaging technique. A follow-up examination may also be

necessary so that any change in a known abnormality can be monitored over time. Follow-up examinations are sometimes the best way to see if treatment is working or if a finding is stable or changed over time.

What are the benefits vs. risks?

Benefits

- CT is fast, which is important for patients who have trouble holding their breath.
- CT is widely available.
- CT scanning is painless, noninvasive and accurate.
- A major advantage of CT is its ability to image bone, soft tissue and blood vessels all at the same time.
- Unlike conventional x-rays, CT scanning provides very detailed images of many types of tissue as well as the lungs, bones, and blood vessels.
- CT examinations are fast and simple; in emergency cases, they can reveal internal injuries and bleeding quickly enough to help save lives.
- CT has been shown to be a cost-effective imaging tool for a wide range of clinical problems.
- CT is less sensitive to patient movement than MRI.
- CT can be performed if you have an implanted medical device of any kind, unlike MRI.
- CT imaging provides real-time imaging, making it a good tool for guiding minimally invasive procedures such as needle biopsies and needle aspirations of many areas of the body, particularly the lungs, abdomen, pelvis and bones.
- A diagnosis determined by CT scanning may eliminate the need for exploratory surgery and surgical biopsy.
- No radiation remains in a patient's body after a CT examination.
- X-rays used in CT scans should have no immediate side effects.
- Low-dose CT scans of the chest use a lower dose of radiation than conventional chest CT.

Risks

- There is always a slight chance of cancer from excessive exposure to radiation. However, the benefit of an accurate diagnosis far outweighs the risk.
- The effective radiation dose for this procedure varies. See the Safety page for more information about radiation dose.
- Women should always inform their physician and x-ray or CT technologist if there is any possibility that they are pregnant. See the Safety page for more information about pregnancy and x-rays.
- CT scanning is, in general, not recommended for pregnant women unless medically necessary because of potential risk to the fetus in the womb.
- The risk of serious allergic reaction to contrast materials that contain iodine is extremely rare, and radiology departments are well-equipped to deal with them.
- In some patients with reduced kidney function, the dye used in CT scanning may worsen kidney function.

- Because children are more sensitive to radiation, they should have a CT exam only if it is essential for making a diagnosis and should not have repeated CT exams unless absolutely necessary. CT scans in children should always be done with low-dose technique.

What are the limitations of CT Scanning of the Chest?

A person who is very large may not fit into the opening of a conventional CT scanner or may be over the weight limit—usually 450 pounds—for the moving table.

Magnetic resonance imaging (MRI) may be better than CT for showing some types of soft-tissue abnormalities.

Even though the CT exam is very fast, motion from breathing or body movement during the exam may result in blurring of the images.

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