The WCC Note™
WorldCare Clinical
A ProScan Imaging Company
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A Weekly Guide To Harmonizing Clinical Trial Imaging
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RADIOLOGY MODALITIES: A QUICK OVERVIEW (Part 2)

TO EDUCATE, INFORM, AND SUPPORT

If the title of this editorial note seems familiar, that's because you read it at the top of the very first issue of The WCC Note*, published last September. With that issue, we kicked off a series of 15 publications dedicated to explaining the basics of medical imaging in simple terms, with special attention to modalities and techniques used in modern clinical trial imaging. In the final two issues of this series, we have tried to sum up the key points covered under each topic area, from conventional x-rays to MRI.*

Beginning next week, The WCC Note *will enter a new phase as a weekly, unbiased source of breaking news and studies of interest to readers in the clinical trial universe. Based on the many compliments, questions, and requests for information we've received from you over the past several four months, you have found this free online newsletter educational and informative – two of our three stated goals.*

As always, we welcome your queries, requests for advice, and comments on the contents we publish here. After all, our third goal is to support you in any way we can. Thanks again for reading The WCC Note, and for passing the word about this publication to your friends and colleagues.

– Stephen J. Pomeranz, M.D., and Resham R. Mendi, M.D.

CT

COMPUTED TOMOGRAPHY (CT)

Main principle: CT is a more complex form of x-ray imaging. In CT, x-rays are not only shot from one source – they come from all around the patient, like a circle of x-rays surrounding the patient's body. The x-rays produced from one side of the patient go through the body or body part and hit a detector on the other side. Then the computer takes the information from each detector about how much radiation went through.

Abdominal CT scan showing an enlarged adrenal gland (arrow).

What the image looks like: The computer makes a picture of the tissues or organs based on density, mapping very dense tissues (like bone or metal) as white, intermediate tissues (muscle, organs) as grey, and less dense tissues (air, fat) as black. CT has the advantage over conventional x-ray that it allows us to see different substances within the body without the overlap. By imaging "tomographic views," meaning slices of the body, we can see each organ individually. The images can be seen in the axial, sagittal, or coronal projections (see Volume 1, Issue 8). The spatial resolution of CT is very good.

Amount of harmful radiation: The amount of radiation from CT is significant, particularly in children and in areas that are more radiation-sensitive (such as the pelvis in a young woman). It children and in areas that are more radiation sensitive (such as the pelvis in a young woman). It ranges from about 1-13 mSv (about 1/3 to three times the amount of normal annual background radiation). A chest CT produces the same amount of radiation as about 100 chest x-rays.

Cost and speed: CT scans are moderately expensive. With the newest multi-detector scanners, CT scans are relatively fast -- from a few seconds to a few minutes.

Some common uses: CT is used very frequently in medical imaging today. Examples include looking for blood in the brain; infection or mass in the chest, lungs, abdomen, or pelvis; blood vessels throughout the body, and fine detail of the bone.

Contrast: Intravenous CT contrast is an iodine-based clear liquid that is usually injected into the patient's IV and appears white on CT scans, localizing to blood vessels and all areas of the body that receive a blood supply. This allows a radiologist to assess for abnormalities in blood vessels, structural abnormalities of organs, and abnormal tissues (such as tumors) that receive either too much or too little blood supply. When a physician orders a CT scan "with contrast" or "without contrast," they are referring to IV contrast only. Contrast allergy in patients is uncommon. Enteric contrast is given orally or rectally to see the gastrointestinal tract better.

Radiation Dose: The amount of radiation received from most CT examinations is significant, because of the use of x-rays from all angles around the patient at multiple levels. For this reason, CT is used less often in young patients and in areas that are particularly sensitive to radiation exposure. For example, the ovaries of a young female are very radiosensitive (see WCC Note, Volume 1, Issue 2), so a CT of the pelvis would be avoided if possible in such a patient. In addition, CT is not used with pregnant women unless the procedure is considered vital to the health of the mother.

Effective Radiation Dosage (in MilliSieverts):

Average background dose in the U.S.	3.6 mSv/year
Three-hour commercial airline flight	0.015 mSv
Chest X-ray (two views)	0.05 mSv
Head CT scan	1-2 mSv
Chest CT scan	5-7 mSv
Abdomen and pelvis CT scan	6-8 mSv
Selective diagnostic coronary angiography	3-6 mSv
Coronary CT angiography	8-13 mSv

Pros:

- Detects calcium, bone, air, gas, blood, and water.
- Fast.
- Interpretation not as challenging as MR.
- Usually more sensitive than x-ray.
- Replaces invasive angiography.
- Contrast allergy uncommon.

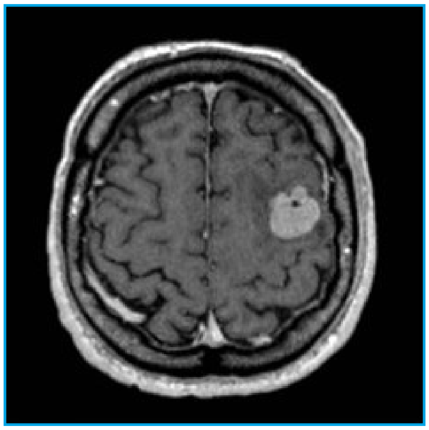
Cons:

- Poorly distinguishes soft tissues from tumors.
- Poor resolution of cartilage.
- Poor distinction of soft tissues from water or proteinaceous fluid.
- Moderate cost.
- Radiation dose is significant — used with caution in children and women of child-bearing age,

and for certain organs that are sensitive to radiation.

MRI

MAGNETIC RESONANCE IMAGING (MRI)



Contrast-enhanced MRI showing mass in the brain's left frontal lobe.

Main principle: MRI uses a magnet and a radiofrequency (RF) wave to manipulate the hydrogen atoms in the body and thus differentiate various tissues.

What the image looks like: In MRI the appearance of substances depends on many factors, including their water and fat content and the MR imaging technique used. The spatial resolution of MRI is good, but less than that of CT.

Amount of harmful radiation: None.

Cost and speed: Expensive and time-consuming.

Some common uses:

- Detailed evaluation of the brain, including anatomy, blood, stroke, tumors, and infection.
- Detailed evaluation of the joints, specifically ligaments, tendons, muscles, and bone marrow.
- Detailed evaluation of the spine for degenerative disease, tumor, and infection.
- Evaluation of anatomic detail of the abdomen and pelvis in children and uterus and ovaries (because of the lack of radiation).
- Evaluation of the breast to look for cancer, distinguish benign from malignant masses, and assess the extent of cancer.
- Evaluation of the heart for congenital abnormalities, or areas of low blood flow or tissue death after a heart attack.

Contrast: Gadolinium is the intravenous contrast agent most commonly used in MRI. Intravenous contrast substances are used in MRI for the same reason as in CT; they are injected into a blood vessel in order to see the blood vessels better, and to see tissues that have varying amounts of blood supply. The incidence of serious reactions is less than 1%. However, nephrogenic systemic fibrosis (NSF), a very serious but rare complication of gadolinium, has been discovered recently in patients with kidney failure. Other contrast agents are much less commonly used, usually for evaluation of tumors *(see Volume Two, Issue 2, for more on angiogenesis)*.

Pros:

- Excellent differentiation of substances in the brain that cannot be differentiated on CT.
- Best-detailed view of soft tissues of the joints, arms, and legs.
- Detailed and accurate evaluation of breast cancers.
- Safe – no radiation exposure.

Cons:

- Relatively expensive and time-consuming.
- Requires an experienced reader.
- Not good for evaluation of calcium or bone cortex – x-rays and CT are better for this.
- Metal may obscure image.

BEGINNING NEXT ISSUE: BREAKING NEWS AND TRENDS IN CLINICAL TRIAL IMAGING

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