National Institute of Technology Raipur

Topic : ECG Scanner and CT Scanner

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ECG Scanner :

Electrocardiography is the process of producing an **electrocardiogram** (**ECG** or **EKG**[a]), a recording of the heart's electrical activity.[It is an electrogram of the heart which is a graph of voltage versus time of the electrical activity of the heart[5] using electrodes placed on the skin. These electrodes detect the small electrical changes that are a consequence of cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat). Changes in the normal ECG pattern occur in numerous cardiac abnormalities, including cardiac rhythm disturbances (such as atrial fibrillation[6] and ventricular tachycardia[7]), inadequate coronary artery blood flow (such as myocardial ischemia[8] and myocardial infarction[), and electrolyte disturbances (such as hypokalemia] and hyperkalemia]).

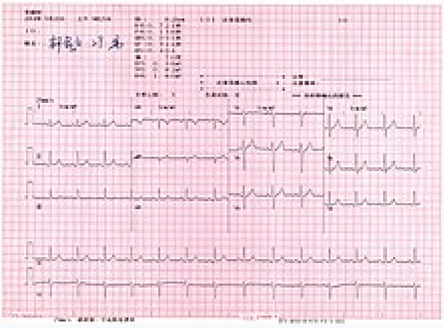
Traditionally, "ECG" usually means a 12-lead ECG taken while lying down as discussed below. However, other devices can record the electrical activity of the heart such as a Holter monitor but also some models of smartwatch are capable of recording an ECG. ECG signals can be recorded in other contexts with other devices.

In a conventional 12-lead ECG, ten electrodes are placed on the patient's limbs and on the surface of the chest. The overall magnitude of the heart's electrical potential is then measured from twelve different angles ("leads") and is recorded over a period of time (usually ten seconds). In this way, the overall magnitude and direction of the heart's electrical depolarization is captured at each moment throughout the cardiac cycle.

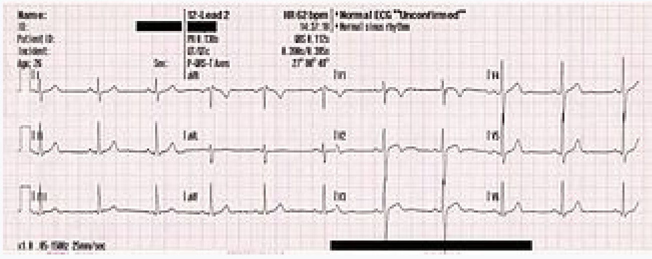
There are three main components to an ECG: the P wave, which represents depolarization of the atria; the QRS complex, which represents depolarization of the ventricles; and the T wave, which represents repolarization of the ventricles.

During each heartbeat, a healthy heart has an orderly progression of depolarization that starts with pacemaker cells in the sinoatrial node, spreads throughout the atrium, and passes through the atrioventricular node down into the bundle of His and into the Purkinje fibers, spreading down and to the left throughout the ventricles. This orderly pattern of depolarization gives rise to the characteristic ECG tracing. To the trained clinician, an ECG conveys a large amount of information about the structure of the heart and the function of its electrical conduction system. Among other things, an ECG can be used to measure the rate and rhythm of heartbeats, the size and position of the heart chambers, the presence of any damage to the heart's muscle cells or conduction system, the effects of heart drugs, and the function of implanted pacemakers.

Medical uses



Normal 12-lead ECG



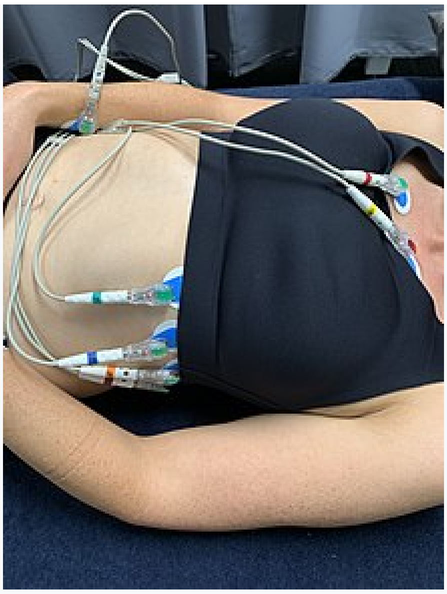
A 12-lead ECG of a 26-year-old male with an incomplete right bundle branch block (RBBB)

The overall goal of performing an ECG is to obtain information about the electrical functioning of the heart. Medical uses for this information are varied and often need to be combined with knowledge of the structure of the heart and physical examination signs to be interpreted. Some indications for performing an ECG include the following:

- Chest pain or suspected myocardial infarction (heart attack), such as ST elevated myocardial infarction (STEMI) or non-ST elevated myocardial infarction (NSTEMI)[17]
- Symptoms such as shortness of breath, murmurs,[18] fainting, seizures, funny turns, or arrhythmias including new onset palpitations or monitoring of known cardiac arrhythmias
- Medication monitoring (e.g., drug-induced QT prolongation, Digoxin toxicity) and management of overdose (e.g., tricyclic overdose)
- Electrolyte abnormalities, such as hyperkalemia
- Perioperative monitoring in which any form of anesthesia is involved (e.g., monitored anesthesia care, general anesthesia). This includes preoperative assessment and intraoperative and postoperative monitoring.
- Cardiac stress testing
- Computed tomography angiography (CTA) and magnetic resonance angiography (MRA) of the heart (ECG is used to "gate" the scanning so that the anatomical position of the heart is steady)
- Clinical cardiac electrophysiology, in which a catheter is inserted through the femoral vein and can have several electrodes along its length to record the direction of electrical activity from within the heart.

ECGs can be recorded as short intermittent tracings or *continuous* ECG monitoring. Continuous monitoring is used for critically ill patients, patients undergoing general anesthesia,[19][18] and patients who have an infrequently occurring cardiac arrhythmia that would unlikely be seen on a conventional ten-second ECG. Continuous monitoring can be conducted by using Holter monitors, internal and external defibrillators and pacemakers, and/or biotelemetry.

Screening



A patient undergoing an ECG

Evidence does not support the use of ECGs among those without symptoms or at low risk of cardiovascular disease as an effort for prevention.This is because an ECG may falsely indicate the existence of a problem, leading to misdiagnosis, the recommendation of invasive procedures, and overtreatment. However, persons employed in certain critical occupations, such as aircraft pilots,[1] may be required to have an ECG as part of their routine health evaluations. Hypertrophic cardiomyopathy screening may also be considered in adolescents as part of a sports physical out of concern for sudden cardiac death

Electrocardiograph machines[edit]

An EKG electrode

Electrocardiograms are recorded by machines that consist of a set of electrodes connected to a central unit. Early ECG machines were constructed with analog electronics, where the signal drove a motor to print out the signal onto paper. Today, electrocardiographs use analog-to-digital converters to convert the electrical activity of the heart to a digital signal. Many ECG machines are now portable and commonly include a screen, keyboard, and printer on a small wheeled cart. Recent advancements in electrocardiography include developing even smaller devices for inclusion in fitness trackers and smart watches.[1] These smaller devices often rely on only two electrodes to deliver a single lead I. Portable six-lead devices are also available.

Recording an ECG is a safe and painless procedure. The machines are powered by mains power but they are designed with several safety features including an earthed (ground) lead. Other features include:

- Defibrillation protection: any ECG used in healthcare may be attached to a person who requires defibrillation and the ECG needs to protect itself from this source of energy.
- Electrostatic discharge is similar to defibrillation discharge and requires voltage protection up to 18,000 volts.
- Additionally, circuitry called the right leg driver can be used to reduce common-mode interference (typically the 50 or 60 Hz mains power).
- ECG voltages measured across the body are very small. This low voltage necessitates a low noise circuit, instrumentation amplifiers, and electromagnetic shielding.
- Simultaneous lead recordings: earlier designs recorded each lead sequentially, but current models record multiple leads simultaneously.

Most modern ECG machines include automated interpretation algorithms. This analysis calculates features such as the PR interval, QT interval, corrected QT (QTc) interval, PR axis, QRS axis, rhythm and more. The results from these automated algorithms are considered "preliminary" until verified and/or modified by expert interpretation. Despite recent advances, computer misinterpretation remains a significant problem and can result in clinical mismanagement

CT Scanner :

A **CT scan** or **computed tomography scan** (formerly known as **computed axial tomography** or **CAT scan**) is a medical imaging technique used in radiology (x-ray) to obtain detailed internal images of the body noninvasively for diagnostic purposes. The personnel that perform CT scans are called radiographers or radiology technologists.[2][3]

CT scanners use a rotating X-ray tube and a row of detectors placed in the gantry to measure X-ray attenuations by different tissues inside the body. The multiple X-ray measurements taken from different angles are then processed on a computer using reconstruction algorithms to produce tomographic (cross-sectional) images (virtual "slices") of a body. The use of ionizing radiation sometimes restricts its use owing to its adverse effects. However, CT can be used in patients with metallic implants or pacemakers, for whom MRI is contraindicated.

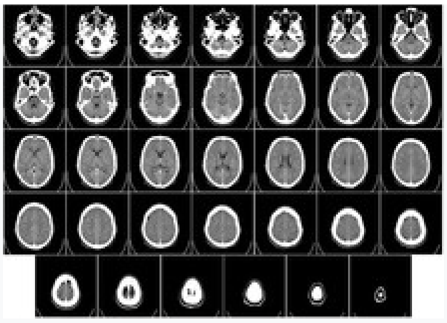
Since its development in the 1970s, CT has proven to be a versatile imaging technique. While CT is most prominently used in diagnostic medicine, it also may be used to form images of non-living objects. The 1979 Nobel Prize in Physiology or Medicine was awarded jointly to South African-American physicist Allan M. Cormack and British electrical engineer Godfrey N. Hounsfield "for the development of computer-assisted tomography".[4]

Medical use

Since its introduction in the 1970s, CT has become an important tool in medical imaging to supplement X-rays and medical ultrasonography. It has more recently been used for preventive medicine or screening for disease, for example, CT colonography for people with a high risk of colon cancer, or full-motion heart scans for people with a high risk of heart disease. Several institutions offer full-body scans for the general population although this practice goes against the advice and official position of many professional organizations in the field primarily due to the radiation dose applied.

The use of CT scans has increased dramatically over the last two decades in many countries.[18] An estimated 72 million scans were performed in the United States in 2007 and more than 80 million in 2015.

Head



Computed tomography of human brain, from base of the skull to top. Taken with intravenous contrast medium.

CT scanning of the head is typically used to detect infarction (stroke), tumors, calcifications, haemorrhage, and bone trauma.[21] Of the above, hypodense (dark) structures can indicate edema and infarction, hyperdense (bright) structures indicate calcifications and haemorrhage and bone trauma can be seen as disjunction in bone windows. Tumors can be detected by the swelling and anatomical distortion they cause, or by surrounding edema. CT scanning of the head is also used in CT-guided stereotactic surgery and radiosurgery for treatment of intracranial tumors, arteriovenous malformations, and other surgically treatable conditions using a device known as the N-localizer.

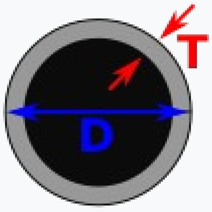
Neck

Contrast CT is generally the initial study of choice for neck masses in adults CT of the thyroid plays an important role in the evaluation of thyroid cancer.[29] CT scan often incidentally finds thyroid abnormalities, and so is often the preferred investigation modality for thyroid abnormalities.

Lungs

A CT scan can be used for detecting both acute and chronic changes in the lung parenchyma, the tissue of the lungs. It is particularly relevant here because normal two-dimensional X-rays do not show such defects. A variety of techniques are used, depending on the suspected abnormality. For evaluation of chronic interstitial processes such as emphysema, and fibrosis, thin sections with high spatial frequency reconstructions are used; often scans are performed both on inspiration and expiration. This special technique is called high resolution CT that produces a sampling of the lung, and not continuous images.

HRCT images of a normal thorax in axial, coronal and sagittal planes, respectively.



Bronchial wall thickness (T) and diameter of the bronchus (D)

Bronchial wall thickening can be seen on lung CTs and generally (but not always) implies inflammation of the bronchi.

An incidentally found nodule in the absence of symptoms (sometimes referred to as an incidentaloma) may raise concerns that it might represent a tumor, either benign or malignant. Perhaps persuaded by fear, patients and doctors sometimes agree to an intensive schedule of CT scans, sometimes up to every three months and beyond the recommended guidelines, in an attempt to do surveillance on the nodules.[35] However, established guidelines advise that patients without a prior history of cancer and whose solid nodules have not grown over a two-year period are unlikely to have any malignant cancer.] For this reason, and because no research provides supporting evidence that intensive surveillance gives better outcomes, and because of risks associated with having CT scans, patients should not receive CT screening in excess of those recommended by established guidelines.

Other uses

Industrial use

Industrial CT scanning (industrial computed tomography) is a process which utilizes X-ray equipment to produce 3D representations of components both externally and internally. Industrial CT scanning has been utilized in many areas of industry for internal inspection of components. Some of the key uses for CT scanning have been flaw detection, failure analysis, metrology, assembly analysis, image-based finite element method and reverse engineering applications. CT scanning is also employed in the imaging and conservation of museum artifacts.

CT scanning has also found an application in transport security (predominantly airport security) where it is currently used in a materials analysis context for explosives detection CTX (explosive-detection device) and is also under consideration for automated baggage/parcel security scanning using computer vision based object recognition algorithms that target the detection of specific threat items based on 3D appearance (e.g. guns, knives, liquid containers).

Geological use

X-ray CT is used in geological studies to quickly reveal materials inside a drill core.[72] Dense minerals such as pyrite and barite appear brighter and less dense components such as clay appear dull in CT images.

Cultural heritage use

X-ray CT and micro-CT can also be used for the conservation and preservation of objects of cultural heritage. For many fragile objects, direct research and observation can be damaging and can degrade the object over time. Using CT scans, conservators and researchers are able to determine the material composition of the objects they are exploring, such as the position of ink along the layers of a scroll, without any additional harm. These scans have been optimal for research focused on the workings of the Antikythera mechanism or the text hidden inside the charred outer layers of the En-Gedi Scroll. However, they are not optimal for every object subject to these kinds of research questions, as there are certain artifacts like the Herculaneum papyri in which the material composition has very little variation along the inside of the object. After scanning these objects, computational methods can be employed to examine the insides of these objects, as was the case with the virtual unwrapping of the En-Gedi scroll and the Herculaneum papyri.] Micro-CT has also proved useful for analyzing more recent artifacts such as still-sealed historic correspondence that employed the technique of letterlocking (complex folding and cuts) that provided a "tamper-evident locking mechanism"