Methods of Investigating Brain

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Topic- Methods of Investigating Brain

(Neuro-imaging & Electrophysiological Procedures)

What is neuro imaging technique

Neuroimaging, or **brain scanning**

✓It includes the use of various techniques to directly or indirectly image the structure, function, or pharmacology of the brain.

✓*It is a relatively new discipline*

✓*Physicians who specialize in the performance and interpretation of neuroimaging* in the clinical setting are known as neuroradiologists

Neuro imaging techniques

Brain imaging techniques have common features:

1. It measures or assay some aspect or characteristics of the brain
2. It translate that information into a visual image or sometimes a numerical printout.
3. It permits the investigator to study the intact , whole, living human brain

Types of neuroimaging techniques

Neuroimaging falls into two broad categories:

1. **Structural imaging**, which deals with the structure of the brain and the diagnosis of large-scale intracranial disease (such as a tumor), as well as injury. Ex- CT scan & MRI
2. **Functional imaging,** which is used to diagnose metabolic diseases and lesions on a finer scale (such as Alzheimer's disease), and also for neurological and cognitive-psychology research.

   Functional imaging allows the brain's information processing to be visualized directly, because activity in the involved area of the brain increases metabolism and "lights up" on the scan. ex- SPECT, PET

Different form of Scanning/ Imaging technique

1. computed tomography (CT),
2. Magnetic resonance imaging (MRI),
3. Positron emission tomography (PET),
4. and single proton emission (SPECT) scans.

Computed tomography (CT scan)

1. uses X-rays to produce three-dimensional images of organs, bones, and tissues.
2. Introduced commercially in 1983
3. This method is an advanced version of the conventional x-ray study,
4. The key principle underlying CT is that the **density of biological material** varies and the absorption of x-ray varies according to density.
5. A CT scan can aid in proper diagnosis by **showing the area** of the brain that is affected

Computed tomography (CT scan)

6. CT scans are particularly useful in people who are unable to undergo MRI.
7. A **contrast dye** may be injected into the bloodstream to highlight the different tissues in the brain.
8. The data is processed and displayed as cross-sectional images, or “slices,” of the internal structure of the body or organ.

Magnetic resonance imaging (MRI)

1. It uses computer-generated radio waves and a powerful magnetic field to produce detailed images of body tissues.
2. **It uses magnetic properties of organic tissues**
3. Using different sequences of magnetic pulses, MRI can show anatomical images of the brain or spinal cord, measure blood flow, or reveal deposits of minerals such as iron.
4. **Unlike CT scanning, MRI does not use ionizing radiation to produce images.**
5. MRI produces images of the brain that look much like CT scans but that have an increased in focus appearance and that are able to discriminate white matter and grey matter.

Magnetic resonance imaging (MRI)

One of the atom that is hydrogen sensitive to magnetic force. Nucleus of hydrogen are always in motion creates a magnetic field.

A radio waves are passed through the tissues and resynchronization in magnetic field generate a picture of the brain.

MRI and CT scan

	CT Scan	MRI
Physical principle	X-ray attenuation	Hydrogen nucleus magnetic resonance
Tissue property measured	Tissue density	Proton density
Slice thickness	2-5mm	Comparatively less 1-3mm

MRS(Magnetic Resonance Spectroscopy)

- is a type of MRI, in MRI magnetic resonance of the hydrogen nucleus is used, But in MRS (Magnetic Resonance Spectroscopy) uses the magnetic resonance of other nuclei, and so it is more helpful to assess a variety of metabolic functions. MRS is structural as well as functional imaging technique.

Functional MRI (fMRI)

- Uses the blood's magnetic properties to produce real-time images of blood flow to particular areas of the brain.
- fMRI can pinpoint areas of the brain that become active and show how long they stay active.
- Researchers use fMRI to study head injury and degenerative disorders such as Alzheimer's disease.
- It focused on the magnetic properties of the hemoglobin.
- It measure ratio b/w deoxygenated and oxygenated heamoglobin(BOLD/Blood oxygenated level dependent)

Positron emission tomography (PET)

- Positron emission tomography (PET) is a type of nuclear medicine procedure that measures metabolic activity of the cells of body tissues
- Since PET is a type of nuclear medicine procedure, this means that a tiny amount of a radioactive substance, called a radiopharmaceutical (radionuclide or radioactive tracer), is used during the procedure to assist in the examination of the tissue under study.

A wide range of compounds used in the PET likewise- fluorodeoxyglucose (FDG), 0^{15} N^{13}, C^{11}

It is based on the assumption that there will be increased blood flow to the regions that have heightened neural activity.

Contd.....

- PET is actually a combination of nuclear medicine and biochemical analysis.
- PET helps to visualize the biochemical changes taking place in the body, such as the metabolism.
- ***It*** provide three-dimensional pictures of brain activity by measuring radioactive isotopes that are injected into the bloodstream.

Positron emission tomography (PET)

- A low-level radioactive isotope, also called a tracer, is injected into the bloodstream and the tracer's uptake in the brain is measured.

Single photon emission computed tomography (SPECT)

- is a nuclear imaging test that can be used to evaluate certain brain functions.
- The image of SPECT is poor than PET.
- SPECT uses compounds that have been labeled with single photon emitting isotopes- iodine 123, xenon 133.
- During a SPECT scan, the person lies on a table while a gamma camera rotates around the head and records where the radioisotope has traveled.,that information is converted by computer into cross-sectional slices

Single photon emission computed tomography (SPECT)

The main difference between SPECT and PET scans is the type of radiotracers used. While SPECT scans measure gamma rays, the decay of the radiotracers used with PET scans produce small particles called positrons. A positron is a particle with roughly the same mass as an electron but oppositely charged. These react with electrons in the body and when these two particles combine they annihilate each other. This annihilation produces a small amount of energy in the form of two photons that shoot off in opposite directions. The detectors in the PET scanner measure these photons and use this information to create images of internal organs

Electrophysiological Proceduress

Electroencephalography(EEG)

- It monitors the brain's electrical activity through the skull.
- EEG is used to help diagnose seizure disorders and metabolic, infectious, or inflammatory disorders that affect the brain's activity
- The electrodes are attached to wires (also called leads)
- Changes in brain wave patterns are transmitted to an EEG machine or computer.
- In people undergoing evaluation for epilepsy surgery, electrodes may be inserted through a surgical opening in the skull to reduce signal interference. This is called an **intracranial EEG**

Electromyography, or EMG,

- is used to diagnose nerve and muscle disorders, spinal nerve root compression, and motor neuron disorders such as amyotrophic lateral sclerosis.
- EMG records the electrical activity in the muscles. Muscles develop abnormal electrical signals when there is nerve or muscle damage.
- During an EMG, very fine needles or wires are inserted into a muscle to assess changes in electrical signals at rest and during movement
- An EMG is usually done in conjunction with a *nerve conduction study (NCS)*. An NCS measures the nerve's ability to send a signal, as well as the speed (nerve conduction velocity) and size of the nerve signal.

Evoked potentials

- ***Evoked potentials***, also called **evoked response**, measure the electrical signals to the brain generated by hearing, touch, or sight.
- One set of electrodes is attached to the person's scalp with conducting paste. The electrodes measure the brain's electrical response to stimuli. A machine records the amount of time it takes for impulses generated by stimuli to reach the brain.
- An **event-related potential (ERP)** is a component of the EEG that is triggered in association with sensory , motor, or mental event

Evoked potentials

- *Auditory evoked potentials* (also called brain stem auditory evoked response) can assess hearing loss and damage to the acoustic nerve and auditory pathways in the brainstem, and detect acoustic neuromas.
- *Visual evoked potentials* detect loss of vision from optic nerve damage
- *Somatosensory evoked potentials (SSEPs)* measure responses from electrical stimuli to the nerves

Transcranial magnetic stimulation (TMS)

- **Transcranial magnetic stimulation** (TMS) is *a procedure in which magnetic pulses are applied to the brain of a living person with the goal of temporarily and safely deactivating a small brain region*.
- In TMS studies the research participant is first scanned in an fMRI machine to determine the exact location of the brain area to be tested. Then the electrical stimulation is provided to the brain before or while the participant is working on a cognitive task, and the effects of the stimulation on performance are assessed.

Transcranial magnetic stimulation (TMS)

- If the participant's ability to perform the task is influenced by the presence of the stimulation, the researchers can conclude that this particular area of the brain is important to carrying out the task. The primary advantage of TMS is that it allows the researcher to draw causal conclusions about the influence of brain structures on thoughts, feelings, and behaviours. When the TMS pulses are applied, the brain region becomes less active, and this deactivation is expected to influence the research participant's responses