BHARATA MATA COLLEGE
THRIKKAKARA

DEPARTMENT OF PHYSICS

A REVIEW ON BRAIN IMAGING

BY,

BALAKRISHNA M S

(Reg.No. 200021036517)

IN PARTIAL FULFILLMENT OF THE COMPLETION OF

BSc DEGREE COURSE IN PHYSICS

CERTIFICATE

This is to certify that the project report titled "**A REVIEW ON BRAIN IMAGING"** is a Bonafede work carried out by **Balakrishna M S**, in the Dept. of physics, Bharata Mata College, Thrikkakara under my guidance during the year 2022-23, the period of final year of BSc Course

Head of department of

Dr. Lini Devassy Physics Barata Mata

college Trikkakara

Project guide

Asst. Professor

Department of physics

Bharata Mata college

Examiners:

1. ....

2. ………………………….

DECLARATION

I **Balakrishna M S,** here by declare that the project report entitled “A Review on Brain imaging ” is a record of original research work done by us under the supervision and guidance of

Dr Lini Devassy and dissertation has not formed the basis for the award of any Degree/ Diploma / Fellowship or similar title to any candidate of this or any other University.

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Thanks to HOD,

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ABSTRACT

The technique of brain imaging have been reviewed. The four main technique – PET Scan, MRI, Near infrared spectroscope, and Magnetoencephalogram, have been studied.

CHAPTER I

INTRODUCTION

Brain imaging uses different methods to observe the indirect pictures of the structure, function of the brain. Brain imaging methods allow doctors and neuroscientist to see the inside of the brain.

The main types of brain imaging techniques are:

1. POSITRON EMISSION TOMOGRAPHY 2MAGNETIC RESONANCE IMAGING 3NEAR INFRARED SPECTROSCOPY 4. ELECTROENCEPHALOGRAM

1.POSITION EMISSION TOMOGRAPHY

Positron emission tomography is the earliest major technology to observe structure and function of the brain. It was brought in 1978. In PET scanning, the measurement of distribution of radioisotopes in the brain is taken using tomographic imaging.

The first radiotracer used was 18F- deoxy glucose (FDG)PET radiochemistry is a major field of study with the aims of observing a variety range of molecular and cellular process in the human brain and how these are changed in psychiatric and neurological diseases.

2.MAGNETIC RESONANCE IMAGING

In structural MRI the NMR of water protons are used to picture the 3D images of tissues. The protons of hydrogen atoms in water vibrate in strong magnetic field.
They take in energy of suitable frequency and emit this energy.

In structural MRI the NMR of water protons are used to picture the 3D images of tissues. The protons of hydrogen atoms in water vibrate in strong magnetic field. They take in energy of suitable frequency and emit this energy. Here radiofrequency is used. Radiofrequency can go through the spinal cord and skull and can give a clear image with no interference. They are also non ionizing radiations hence MRI is safe.

3.ELECTROENCEPHALOGRAM

The magnetic fields produced by electric currents in the brain is measured by magnetoencephalogram. It ranges from femtohm to pico-tesla. They provide an accurate resolution of the neuronal activity. Magnetic encephalogram detects the magnetic fields produced by the electric currents in the brain. The tissues have a magnetic permeability similar to empty space and hence they are not distorted by the skull or scalp. The neurons generate electrical signals and thus producing magnetic fields which are detected by the MEG

The magnetic field produced by the body is very low hence special equipment's are used to detect them. The technology used is super conducting quantum interference detectors

4.NEAR INFRARED SPECTROSCOPY

Near infrared spectroscopy utilizes the infrared radiation of wavelength 650950nm to find the oxygenation and amount of haemoglobin in the brain and other cells.

CHAPTER II

1. POSITION EMISSION TOMOGRAPHY
2. MAGNETIC RESONANCE IMAGING
3. NEAR INFRARED SPECTROSCOPEY
4. ELECTROENCEPHALOGRAM

POSITRON EMISSION TOMOGRAPHY

The human brain is one of the most complex things in the universe. It controls almost all functions of the body. An average human brain weighs around 1.3kg and it is 60% fat, the remaining is a combination of salts, carbohydrates water and proteins. The brain can receive chemical and electrical signals throughout the body. The activities of the brain can be understood by various techniques. Position emission tomography is one such technique.

PET is a type of nuclear medicine imaging. Nuclear medicine uses small number of radioactive compounds to diagnose or treat diseases. Here radiotracers are injected into the body through veins or swallowing. After reaching the organs to be observed, the tracers' releases energy in the form of gamma radiations.

These are detected by Pet scanners. A pet scan accurately detects variety of conditions such as brain disorders like dementia, seizures and tumours, heart conditions such as places with low blood flow, pet detects cancers as bright spots due to the higher metabolism rate. The duration of the procedure is about 2 hours. Before the procedure the patient is instructed to change to hospital gown, the patient will be asked to empty their bladder before to the start of the procedure. and then the doctor injects the tracer into the veins and patient must rest for an hour. After that the patient is taken to the scanner where they are to lie down in a narrow table that slides to the scanner. After the procedure the patient is advised to drink fluids to remove the tracer from the body. The test results are examined by an expert and it Is compared with other results from other tests. Although the pet scan is a safe procedure it still has potential risks such as a allergic reactions, pregnant women may expose their baby to radiation.

The first usage of the PET equipment was made by physicist Gordon Brownell and William Sweet in the 1950s at Massachusetts General hospital. The equipment was used to detect brain tumours with sodium iodide. Now PET with 18-fluoro-2-deoxyglucose (18F-FDG) along with CT has been highly become a wide used imaging technique for the diagnosis and treatment of cancer. 2-[18F]-fluoro-2-deoxy-D-glucose (FDG) is a frequently used PET ligand. FDG PET gives the quantity of cellular glucose metabolism. FDG is taken into cells by glucose transporters. It undergoes only the first step in glucose metabolism.

FDG deposition in the brain is depends on regional cerebral metabolic rate, which is related to neuronal and synaptic function. FDG is FDA sanctioned for the identification of seizure and for cardiology disorders. It has been in used in studies of depression, bipolar disorder, schizophrenia, traumatic brain injury, and other brain related disorders. Many things can alter FDG intake, which includes glucose level in the blood, medication, and emotional state. Presence of some brain activating medications like benzodiazepines can alter intake of FDG. Insulin can change the concentration of FDG by the intake to muscles, so it is suggested that patient don't eat and have fluids containing dextrose or parenteral feeding withheld for 4-5hours before administration of FDG. In diabetic patient's blood glucose levels may become high to the point of competing with FDG for uptake into the blood. The level of glucose in the blood should be taken before the injection of FDG in all patients. Drinking water is important to assure rapid renal clearance, which decreases background activity and patients' radiation exposure. FDG is injected slowly with time so that the patient needs to remain in a healthy environment for 30 min after procedure.

STUDY OF CANCER USING PET SCAN

Detecting cancer in the early stages have a major role in curing cancer. A latest data revealed that a number of suggestions are there based on a limited amount of reliable data. Suggestions and decisions for cancer screening should be on the basics of trustable data and not on the basis of assumptions. Therefore, we need to study the theory and the environment of screening and then discuss recent controversies regarding screening for brain, lung, and breast cancers. Currently some doctor's advice PET, CT or PET/CT for whole-body testing without evidence from trustable information. We need to consider the possible financial, radiation safety and legal things related with the full-body PET or CT cancer testing. Instead of giving a specific answer that is presence of absence of cancer, the procedures always give uncertain readings that require further evaluation followed by costly methods.

The detection of diseases in people having no symptoms but have a high chance of potential diseases is known as screening. Screening should find most of the individuals having accurate results and find few people with false results. But majority of the people undergoing screening do not have the disease. The use of screening must be to stop or delay the deaths that may happen due to the disease.

PET scans can examine how tissues and cells work. Cancer cells have a higher metabolic rate than non-cancerous cells. Due to the high activity of these drugs, cancer cells appear bright on PET scans. For this purpose, PET scan can be used to diagnose cancer. PET scan can detect viable tumours. Prior to the PET scan, the patient is given an injection of a drug containing sugars bound to a radioactive isotope. Cancer cells absorb glucose and the isotope to which binds, emitting low-energy electrons (positrons). positrons react with electrons in cancer cells to produce gamma rays. The PET machine then detects the gamma rays and converts the data into images. If no gamma rays are seen in the scan area, the probability of cancer in the body is low. PET scanners find radiotracers to produce images of the organs. The radioisotopes decay by releasing positron, which get destroyed due to Collison with electron. Due to these two gamma photons are formed with are traveling in opposite direction with an energy of 511eV. These photons strike the opposite detectors simultaneously. The scintillator detector then converts the 511 keV photons into light, which is recognized by the attached photomultiplier tube. The path between two detectors where overlaps is called the Response Line (LOR). LOR plays an important role in the accuracy of in PET because LOR provides information about the location of the event compared to single-photon imaging. The algorithm was applied to the data from and the final spatial distribution (5-10mm) of the radiotracer affected the study process. By analysing metabolism, enzymatic activities, protein aggregation, and receptor binding, abnormalities in PET images can be detected before changes in imaging patterns are seen. Compton scatter affects the quality of the PET images. Interaction of the photons with electrons causes change in direction, which causes shift in the LOR. This reduces the energy of the photon. Some scattering can be overcome by adjusting the threshold energy. However, some bursts of photons hit the detector with an energy higher than the threshold. PET is susceptible to attenuation as two photons must be detected for each simultaneous event. Radiotracers are molecules that are connected to a small amount of radioactive substance that can be identified on the scanner. Commonly used radiotracer is fluorine-18 (18F) or carbon-11 (11 C). They are produced by a cyclotron. Since the half-life of radiotracers are small, they don't expose patients to deadly radiations. The very short half-life of 11C limits its use to centres with an on-site cyclotron. There are lot of conditions to be met for using a molecule as radiotracer. They should provide signal low enough to prevent dangerous effects. The radiotracer must have highly specific binding to the target and low nonspecific binding. The radiotracer should localize rapidly to the target. For brain imaging, the radiotracer must go to its target by crossing the blood brain barrier. Main other factors are size, protein binding, size, and polarity.

MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging (MRI)t uses strong magnetic fields and radio waves to produced accurate picture of the inside of the body. Raymond Dalmatian invented the first MRI full-body scanner, in an MRI scan there is a large magnet, radio waves, and a computer to create a detailed, crosssectional image of internal organs and structures. The scanner is like a large tube with a table in the middle, allowing the patient to slide in. At the time of the scan the patient is to lie on a table that slides inside a MRI. Patient must be still during the process. The professionals will offer you earplugs. The brain and spinal cord can be examined in detail using MRI.

BRAIN MRI

An MRI scan creates accurate pictures of the structure of the brain and other parts of head . MRI can be used to study, diagnose and observe other different diseases that affect the brain and other parts . The blood vessels in the brain joins the brain with other structures of the head. A head MRI can visualize the irregularities in the brain or the surrounding tissues,

Swelling and structural issues like iregular growth, brain haemorrhage which is the bleeding inside the brain , white matter disease. Doctors and other health takers suggest brain MRI for variety of reasons, which include identify new disease on the basis of certain problems or to examine existing condition. Detection of symptoms like migraine and frequent aches , seizure and frequent occurance of weakness, ear problems with an undetectable reason, eye problems that cannot be identified in an eye test, hormone irregularities associated to the brain and pituitary gland changes to your thoughts and behaviour and tiredness can make the doctors recommend MRIs .Doctors also use brain MRIs before operations involving the brain to accurate preperation for the operations . Extreme injuries related to the brain also makes the doctors suggest brain MRIs to examine for damages , bleeding and inflammation.

WORKING OF MRI

MRIs uses strong magnets that creates a strong magnetic field that makes the protons in the body to align with it. Then a radiofrequency current is pulsed through the patient. This stimulates the protons, and it spins of the equilibrium, against the pull of the magnetic field. When the radiofrequency current cuts the MRI sensors identifies the energy emitted and the protons are realigned with the magnetic field. As the conditions and chemical nature changes the time required for the protons to align with the magnetic field and the energy emitted will vary.

In an MRI electric current is passes through coiled wires to create a temporary magnetic field in the patient's body Radio waves are sanded by a transmitter or receiver. These signals are then converted to images of the part being observed. During MRI exposure to radiation is zero hence have no risks related to radiation. But because of the strong magnet in the MRI patients are not allowed to have any metal materials. Those having pacemakers must take special measures before the testified: Functional magnetic resonance imaging of the brain (fMRI) is helpful to identify the parts of the brain where a different functions , like talking or thought happen. The parts of the head in which these function happen is found but the specific places may vary from patient to patient. During fMRI, the patient will be suggested to perform different functions, such as singing when the fMRI is performed. By pointing the correct location of the functional centres in the brain, doctors can plan surgery or other treatments for a particular disorder of the brain

PHYSICS AND HUMAN BRAIN

Physics related thoughts raises the activity of the brain and improve parts of the brain. Eric Brewe and Jessica E. Bartley are the study's lead authors.

The study Involved 55 students from Florida International University. Modelling Instruction is a teaching method that helps students think like physicists through the collaborative development of mental models that account for observing phenomena, researching and discussing and revising their models until they can have accurate predictions

The students' brains were scanned using functional magnetic resonance imaging before and after the Instructions. It observed activities due to changes in blood flow In either of the time, fMRIs were performed while students completed a modified version of the Force Concept Inventory test optimized for the study. The 30-question quiz had been simplified down to just nine questions that "required students to determine the trajectories and motion of objects as resulting from different scenarios and combinations of initial velocities and/or force configurations the test had been pulled to focus on both," according to the study. .

Also the expected output for the choice based question was decreased to four from five in order to fit the four buttons control students used in the scanning/test. The students under study also had to answer some questions that didn't related to physics

Findings: the fMRI showed that grasping topic of physics questions stimulates the part of the prefrontal cortex. After the sessions, connection to episodic memory and self-referential thought, the posterior cingulate cortex, was active at the time of test. This may, says the study, reveal shifts in strategy or an increased access to physics knowledge and problem-solving resources reflecting more complex behavioural changes in how students' reason through physics questions

To find the parts of the brain that makes physics-based computation, Jason Fischer and a team of scientists from MIT had 12 participants to look at video of Jenga-style blocks assembled in a tower. While scanning their brain activity with fMRI, the researchers asked the participants to predict where they thought the blocks might land if the tower were to collapse.

The fMRI results showed that the premotor cortex and the supplementary motor parts were the most active areas, whereas a simple visual test in which the participants only had to identify whether the static tower contained more blue or yellow blocks, didn’t stimulate activity in their physics engine.

Regardless of whether you guess the correct responses based on each tower, the premotor cortex and the supplementary motor area of the brain are engaged when attempting to understand it. In a final experiment, participants merely watched brief watching films with a lot of physics information while exercising their brains monitored. Even without being asked to give any sort of reaction to the clips, they merely had to watch the film since the outcomes demonstrated that the physics engine in the brain was Premotor cortex is stimulated, and the more physical stuff is displayed, the more so activation of the supplementary motor areas. Even when viewers weren't consciously aware of it, brain activity indicated the quantity of physical content in a film. This implies that we constantly draw conclusions about the physical world, even when we aren't consciously doing so.

NEAR INFRARED SPECTROSCOPY

Near infrared spectroscopy is a method used for the measurement of the haemoglobin content in the blood. It is an optical picturing method. The principle of near infrared spectroscopy is that it uses the light absorbing property of blood of certain wavelength. Haemoglobin in the blood can absorb wavelength near the infrared region. Hence we can identify oxygenated and deoxygenated blood.It also helps us to find the reducing and oxydising state of cytochromes. The data obtained is expressed jn percentage and it provides the composition data.The difference in the composition of oxygenated and deoxygenated blood is associated with the brain activity. Often Near infrared spectroscopy uses laser sources with dual wavelength and high sensitive detectors to picture the brain.The blood oxygenated level obtained from the NIR Spectroscopy can be used to develop 3D images of the brain.

There are 4 varieties of Near infrared spectroscopy which include functional near infrared spectroscopy, time domain, continious and frequency domain.The thickness of the bones and concentration of the haemoglobin can alter the accuracy of the imaging.

FUNCTIONAL NEAR INFRARED SPECTROSCOPY

This method uses the difference in the haemoglobin content using difference in Optical absorbing property.The light near the infrared spectrum can pass through the body and tissues and the cytochromes intake these radiations. The advantage of this method is that it can be easily transported and can be used for long term. By analysising the infrared radiation absorbed we can estimate the changes in the blood flow.

fNRI is mostly used in pediatric ICUs to analyse the oxygen amount. This method measures variety of haemoglobin in separate ways. fNIRS is an extremely safe method and can be used in patients that are not eligible candidates of MRI scan.

The relative transparency of living tissues (including bone) to light for infrared wavelengths between 650 and 925 nm allows for near-infrared spectroscopy in the brain. Oxyhemoglobin and deoxyhemoglobin absorb light in this range significantly more strongly than adjacent and overlaying tissues. For these two chromophores, deoxyhemoglobin absorbs infrared light more strongly below 790 nm and oxyhemoglobin more strongly above 790 nm as a function of wavelength. fNIRS enables the investigation of the brain’s energy metabolism by detecting changes in the relative concentrations of several light-absorbing substances. For instance, fNIRS can assess variations in oxygenated and deoxygenated haemoglobin in a way that is comparable to fMRI, reflecting changes in regional neural activation. The cortical surface must be exposed to enough near-infrared light for this to occur. A certain method can be used to account for the static light-absorbing properties of the surrounding tissue and anticipate the amount of light that is attenuated by the skull, scalp, and meninges.

COMPARISON OF NIRS WITH OTHER BRAIN IMAGING METHODS

In a typical NIRS application, the light emitter and detector are attached using glue or, more recently, by simply donning a customised cap with pre-positioned sockets for optode sites. The signals are then sent through fiberoptic cables to the main equipment, which can be anything from a compact, two-channel box the size of a cigarette pack to a full-brain scanning system the size of a washing machine, both of which are connected to a laptop computer.NIRS systems can be simply installed in a car for field-based monitoring or utilised with a simulator because this enables the subject to sit upright and without restriction on simple hand movement.NIRS has a higher temporal resolution than fMRI, enabling real-time evaluations. NIRS signals can theoretically be compared to the BOLD response obtained with fMRI, making NIRS capable of similar brain mapping with outcomes equivalent to lab-based fMRI findings, according to recent studies comparing NIRS and fMRI across several paradigms.

Although NIRS can access several brain regions that may be significant for driving and attentional control research, it only measures superficial cortical areas (the banana-shaped regions penetrated through by the nearinfrared light with a depth of 20–30 mm) and cannot inspect deep brain structures. These include the motor areas, parietal lobule, and prefrontal cortex. Cerebrocranial correlation is thought to have fidelity of within 10 mm when NIRS probes are put in accordance with the international system for EEG, allowing appropriate resolution at the level of the gyrus. Support vector regression learning algorithm, which allows NIRS to infer deeper brain regions, has also recently been used

Additionally, with almost no run-time costs, NIRS is safe for almost all populations (including those who cannot undergo fMRI due to implanted pacemakers or magnet sensitivity).Additionally, NIRS measures both oxygenated and deoxygenated tissues and offers the possibility of more accurately quantifying observed concentration changes as opposed to fMRI's secondary vascular response.NIRS provides superior spatial resolution (10-30 mm) than EEG, which can be employed in scenarios comparable to upright driving and allows localising brain activation in particular functional regions. Due to electrical signals in one location influencing detection at other locations, localization is more challenging with EEG, resulting in a generally coarser view in the absence of advanced source technology. Activity at each location cannot always be attributed to neural activity close to that region.Additionally, NIRS can tolerate motion artefacts as well as most EEG or even better.It has also been demonstrated in prior research employing simultaneous NIRS and EEG that the themodynamic response has a usually linear connection to the neuronal activity as measured by event-related electromyographic potentials, possibly enabling NIRS to provide both metrics.

ELECTROENCEPHALOGRAM (EEG)

Electroencephalogram (EEG) is a documentation procured by the attachment of 20 to 256 electrodes to the human scalp which provides the data the oscillations of brain electric potentials.

Electroencephalography (EEG) is a non-invasive method of recording the electrical activity of the brain using electrodes attached to the scalp. EEG provides a measure of the brain's electrical activity and is produced by the communication between neurons in the brain. The EEG signal is characterized by different frequencies and forms, that can provide information about the state of the brain. Frequency of the EEG signal is often categorized into different bands, i.e delta (0.5-4 Hz), theta (4-8 Hz), alpha (8-13 Hz), beta (13-30 Hz), and gamma (30100 Hz), each of which is associated with different brain states and functions. EEG is used in a wide range of applications also including clinical diagnosis, research in psychology and neuroscience as well as cognitive and neurological assessment. In clinical settings, EEG is used to diagnose and monitor various neurological constrains such as epilepsy, sleep disorders, and brain injuries. In research settings, EEG is utilized to investigate brain function and communication, as well as to study cognitive and behavioural processes such as the attention, memory, and perception.

The electrical and neural activity of the brain is generated by the communication between neurons, which produce synchronized electrical currents. These currents create a fluctuating voltage on the scalp that can be recorded by the electrodes. The EEG signal is differentiated by different frequencies and exhibits, which can provide information about the state and condition of the brain. The EEG signal is analysed using different techniques, such as time-domain analysis, frequency domain analysis, and event-related potentials (ERPs). Time-domain analysis includes examination of the amplitude, duration, and shape of the EEG waveform, while frequency-domain analysis includes breaking down the EEG signal into different frequency bands, i.e delta, theta, alpha, beta, and gamma. ERPs are specific changes in the EEG signal that are timeconsistent to a particular stimulus and can provide information about cognitive and neural processing and methods. The EEG signal can be affected by various factors, such as age, gender, medication, sleep, and neurological conditions. In clinical ecology, EEG is often used to diagnose and detect neurological conditions, such as epilepsy, brain injuries, and sleep disorders. In research settings, EEG is used to probe brain function and communication, and to study cognitive and behavioural processes, like attention, memory, and perception. EEG has several advantages over other neural imaging techniques, such as fMRI and PET. EEG has a high temporal resolution which means it can detect changes in brain activity just with millisecond precision. EEG is also proportionally inexpensive and portable, making it suitable for use in a variety of conditions. EEG has lower spatial resolution compared to other techniques, as it only measures the activity on the surface of the scalp and cannot detect activity in deeper brain structures.

Working of EEG

To record the electrical signals, electrodes are fixed on the scalp of the person undergoing EEG. The electrodes are attached to a machine called an Electroencephalogram amplifier amplifies the electrical signals picked up by the electrodes. The amplified signals are then fed into a computer for further detection and analysis. During recording, the person is typically asked to relax and remain still with their eyes closed. The electrical activity recorded by the electrodes is then displayed as of wavy lines on a computer screen or on paper.

The wavy lines in an EEG recording are called brain waves, and they reflect the activity of different parts of the brain. The brain waves are classified into different types based on their frequency and amplitude. The different types of brain waves are:

- Alpha waves: These are low-frequency waves (8-12 Hz) that are typically present when a person is relaxed with their eyes closed.
- Beta waves: These are high-frequency waves (12-30 Hz) that are typically present when a person is alert and focused.
- Theta waves: These are low-frequency waves (4-8 Hz) that are typically present during light sleep or meditation.
- Delta waves: These are very low-frequency waves (0.5-4 Hz) that are typically present during deep sleep.

The procedures involved in EEG (electroencephalography) can be summarized as follows:

- Preparing patient: Before the EEG recording, the patient is asked to wash their hair with shampoo to remove any oils lotions or other substances that might interfere with the electrode placement and attachment. The patient should void consuming caffeine or other stimulants prior to the recording.

- Placing electrodes: The patient sits in a comfortable chair or lies down on a bed, and the EEG technician places a cap or individual electrodes on the patient's scalp. The electrodes are attached with a conductive gel or paste, and are placed at specific locations according to an international standard called the 10-20 system.

- Recording the EEG: Once the electrodes are in place, the EEG recording begins. The patient is asked to remain still and relaxed with their eyes closed, but in some cases, they may be asked to perform specific tasks, such as looking at a flashing light.

- Monitoring and interpreting the EEG: During recording, technician monitors the EEG signal for any artifacts, such as muscle movements or electrical interference. After the recording is complete, the EEG signal is analysed by a neurologist or other specialist, who interprets the patterns of brain activity and looks for any signs of abnormality or disease.

- Reporting the result: The EEG results are reported in a written report that is sent to the patient’s referring physician. The report may include information about the patient's brain wave patterns and changes, any abnormalities that were detected, and recommendations for further
- testing or treatment.

HAZARDS OF EEG

- EEG (electroencephalography) is generally considered to be a safe and non-invasive with very few hazards or risks. However, there are some potential hazards or discomforts associated with EEG, which include:

- Discomfort or irritation: The conductive gel used to attach the electrodes to the scalp can sometimes cause minor irritation or discomfort, although this is usually temporary and not permanent.
- Allergic reaction: In certain cases, a patient may experience an allergic reaction to the conductive gel or paste used to attach the electrodes. Symptoms are itching, redness, or swelling at the electrode sites.
- Claustrophobia: Some patients may experience anxiety or discomfort during the EEG recording if they feel claustrophobic or confined by the cap or electrodes.
- Rare electrical hazards: In rare cases, an electrical hazard may occur if there is malfunction in the EEG equipment, although this is extremely uncommon and most modern equipment is designed to prevent such occurrences.

- False-positive results: In rare cases, EEG recordings may be misinterpreted or may produce false-positive results, which can lead to unnecessary further testing or treatments.

Overall, the risks and hazards associated with EEG are very minimal, and the benefits of this diagnostic tool typically outweigh any potential risks.

EEG can affect the brain in multiple ways. One is by providing feedback to individuals about their brain activity. This technique, known as neuro -feedback, has been used to train individuals to regulate their brain activity in order to improve performance on tasks or alleviate symptoms of neurological disorders. For example, neurofeedback has been used to treat ADHD, anxiety, and depression.

Another possibility that EEG can affect the brain is by altering neural oscillations. Neural oscillations are rhythmic patterns of activity in the brain that are thought to play a role in several cognitive processes. By applying electrical stimulation to the scalp, researchers can modulate neural oscillations and potentially enhance cognitive performance.

Research has suggested that EEG can have therapeutic effects on the brain. For example, studies have exhibited that trans cranial alternating current stimulation, a technique that involves applying electrical stimulation to the scalp, can improve memory and cognitive performance in healthy individuals and in individuals with neurological disorders issues. EEG can provide valuable information about the brain's functioning and has potential therapeutic applications. However, more research is needed to fully understand the mechanisms underlying the effects of EEG on the brain and to develop effective interventions for neurological disorders.

- The future of EEG, advances in technology making it possible to collect more precise and detailed information about brain activity. Some potential future developments in EEG:
- Wearable EEG devices: EEG headsets that can be worn like cap or helmets are already available in the market. As technology improves, we can expect to see smaller, comfortable, and more affordable devices that can be worn for extended periods.
- Wireless EEG: EEG recordings electrodes to be attached to the scalp using a gel or paste. In the future, wireless EEG technology may become more common, allowing for more freedom of movement and easier data collection.
- High-density EEG: High-density EEG systems use more electrodes than standard EEG systems, allowing more precise mapping of brain activity. This is already being used

in research, and can be expected to see it become more widely available in the future.

- EEG and machine learning: Machine learning algorithms can analyse huge amounts of EEG data to identify patterns and make predictions. In future, EEG and machine learning may be used to diagnose neurological disorders or predict treatment outcomes.
- EEG and virtual reality: EEG can be used to measure brain activity in response to virtual reality environments. It may be used to create personalized virtual reality experiences for therapeutic purpose

In conclusion, EEG is a valuable tool for understanding brain function and identifying neurological disorders. It provides important information about the timing of neural activity, which can help diagnose and monitor conditions such as epilepsy, sleep disorders, and traumatic brain injury. Additionally, EEG can be used in research to investigate brain activity during cognitive tasks, emotional processing, and other mental states. Recent advances in technology have led to the development of portable and wireless EEG devices, which offer greater flexibility and convenience for patients and researchers. However, EEG has some limitations, including its inability to accurately localize the source of neural activity and its susceptibility to artifacts from movement, eye blinks, and other sources.

Overall, EEG remains a valuable tool in neuroscience and clinical practice, providing insights into brain function and helping diagnose and treat neurological disorders. Continued advances in technology and methodology will further enhance its capabilities and broaden its applications in the future.

CHAPTER III

SCOPE & CONCLUSION

SCOPE

The scope of brain imaging is vast and encompasses a wide range of research fields and clinical applications. Brain imaging techniques are used to study the structure, function, and connectivity of the brain in health and disease, and they have been instrumental in advancing our understanding of the human brain.

In research, brain imaging is used to study basic brain functions such as perception, attention, memory, and decision-making. It is also used to study more complex processes such as language, emotion, and social behaviour. Brain imaging has led to many important discoveries in neuroscience, such as the role of specific brain regions in cognitive processes, and the plasticity of the brain in response to experience.

In clinical settings, brain imaging is used to diagnose and treat neurological and psychiatric disorders. Brain imaging can help identify structural abnormalities in the brain that may underlie cognitive and behavioural symptoms. It is also used to monitor disease progression and treatment effectiveness. Examples of conditions that can be diagnosed or monitored using brain imaging include Alzheimer's disease, Parkinson's disease, multiple sclerosis, epilepsy, and stroke.

Brain imaging is also increasingly used in the development of new therapies and interventions for neurological and psychiatric disorders. For example, brain imaging can be used to identify potential targets for pharmacological or neuromodulator interventions, and to monitor the effects of these interventions on brain function.

Overall, the scope of brain imaging is vast and constantly expanding, and it has become an essential tool for understanding the brain and developing new treatments for neurological and psychiatric disorders.

CONCLUSION

brain imaging is a rapidly evolving field that has revolutionized our understanding of the brain. With the development of increasingly sophisticated imaging techniques, we are now able to study the structure, function, and connectivity of the brain in unprecedented detail. Brain imaging has led to many important discoveries in neuroscience, and has helped us to identify the underlying mechanisms of various neurological and psychiatric disorders. It has also provided us with valuable tools for diagnosis, monitoring, and treatment of these conditions.

However, brain imaging is not without limitations, and there are still many challenges that must be overcome. For example, some imaging techniques are invasive or require exposure to radiation, and there is still much we do not understand about the complex interactions between different brain regions. Nevertheless, the potential for brain imaging to continue to advance our understanding of the brain and improve clinical outcomes for patients is enormous. With ongoing advances in technology and methodology, we can expect brain imaging to remain at the forefront of neuroscience research and clinical practice for many years to come.

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