ANALYTICAL TECHNIQUES USED FOR DISEASE DIAGNOSIS
– INVASIVE AND NON-INVASIVE TOOLS

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ABSTRACT

Recent advances in signal analyses have opened the way to utilize different imaging techniques with the status of a true mapping and imaging methods. Because of the increasing interest in the 3D visualization and cross section images, various diagnostic tools such as MRI, ECG, EEG and Ultrasound have gain importance. These techniques provide a way to diagnose the diseases efficiently and in their early stages without any damage or incisor. But this cannot fully overtake the usage of invasive techniques such as blood test, amniocentesis, lumber puncture and biopsy. On one hand they provide the primary diagnosing as in case of blood test and on other hand they provide confirmation of the results given by imaging techniques as in case of biopsy. This paper discusses the ideas of invasive and non-invasive diagnostic techniques with their side effects.

AMNIOCENTESIS

INTRODUCTION

Amniocentesis is a technique which can identify the defects in developing fetus during pregnancy. In this technique amniotic fluid is collected for sampling. This is done by the use of needle and syringe. Further the tests are performed on this sample by the doctors and pathologist who then identify any sort of disease including genetic disorders. This helps the parents to take precautions and treatment, if possible [18]. Amniocentesis can be performed early and even slight late during the course of pregnancy. The early one is performed within three to four months of pregnancy [22,38] whereas late is performed useful and important test for detecting Down syndrome, nonhereditary, genetic birth defect, after four months are over [18]. Since past 4 decades, amniocentesis has become a very afflicting about one in every 1,000 babies. Not only this, it is routinely used for diagnosis of Tay - Sachs disease, sickle cell anemia, hemophilia, muscular dystrophy, and cystic fibrosis.
Amniocentesis is performed mainly by the women who have crossed their 30s to identify if any defects are present in the fetus. It is also recommended to those who have family inherited genetic disease. As the age of women increases, the probability of birth defects increases because of the aging of the egg. Amniocentesis thus prevents a woman from holding the defective fetus which can either give rise to a dead or defective baby. It is also performed for the analysis of abnormal alpha fetoprotein which is produced by the fetus and is then added to the mother system. The levels of AFP are then tested in the mother’s system; if it is very low or very high it indicates the abnormalities in fetus. Amniocentesis should be performed as early as possible because it increases the risk of miscarriage. If it is performed early, it not only provides safety but also provide time to the parents to decide whether they want baby, treatment or abortion and abortions if performed earlier are safe [9].

TECHNIQUE

Amniocentesis technique requires specialized and experienced hands. The procedure starts with the insertion of needle inside the abdomen to reach to the amniotic fluid present in the amniotic sac. This whole procedure requires the help of ultrasound technology for looking the path of needle tip at every second. This increases the effectiveness of the method and make it more successful with enhance safety. Syringe used for taking out the amniotic fluid is 10 to 20 ml [33]. In most cases 1ml of amniotic fluid is projected out for further testing which includes DNA analysis and chromosomal analysis. Recently it is diagnosed that little amount of amniotic fluid should be aspirated as the probability of fetal loss increases with the amount of amniotic fluid extracted out [13]. There is a lot of difference in the membranes physiology and anatomy when 4 months membrane is compared with late first trimester [30].
COMPLICATIONS

Amniocentesis is very useful technique but as in nature everything has bad side too so is the case with the technique. The drugs that relax the uterus (tocolytics) can also cause harm to the fetus. Most pregnant women wish to be reassured that their unborn baby is healthy. This expectation increased in the last few decades but due to this the women are likely to be at increased risk for fetal loss and other complications. The technique can lead to vaginal bleeding and amniotic leakage after test or after 20 weeks. It can also cause prelabour ruptured membranes in less than 28 weeks and delivery in less than 37 weeks [8]. An increased risk of early delivery was detected in women having amniocentesis in second trimester even after taking account of other risk factors and confounding variables [7].

ADVANCES

Many other techniques are widely combined with the existing amniocentesis to enhance its diagnostic field and success rate. Fetal sex can be thoroughly studied by the polymerase chain reaction (PCR) using cells from fetal fluid collected by ultrasound-guided amniocentesis. The transducer used is equipped with a 65-cm long, 21-g needle within the probe carrier. A male-specific primer and a gender-neutral primer are used for PCR process. The procedure requires considerable skill and is not without some risk to fetal viability [25]. The four-dimensional ultrasonography is getting wide applications nowadays to increase the efficiency of technique and its safety. Using it as a guide, most procedures were performed within 5 min and with a 100% success rate [26]. It provides good results even in cases involving severe oligohydramnios (amniocentesis), thin placenta (CVS) or narrow umbilical veins (cordocentesis). Moreover, no serious complications during or after the procedure are seen.

RELEVANT RESULTS

The result obtained can either be normal result or abnormal result. The negative results from an amniocentesis analysis indicate that everything about the fetus appears normal and the pregnancy can continue without any concern. A negative result for Down syndrome means that it is 99% certain that the disease does not exist. But as the laboratory tests are not 100% accurate, an overall "normal" result does not however, guarantee that the pregnancy will be successful, or that the fetus does not suffer from some other defect. On the other hand positive results of amnio analysis indicate the presence of a fetal defect, with an accuracy approaching 100%. With such a diagnosis, prospective parents face emotionally and ethically difficult choices regarding prenatal treatment options, the prospect of treating the defect at birth, and the option of elective abortion. At this point, the parents need expert medical advice and counseling [14,20,37].

SIDE EFFECTS

Most of the risks and short-term side effects associated with amniocentesis relate to the sampling procedure. A successful amnio sampling results in no long-term side effects [14,20,37]. Risks include: Maternal/fetal hemorrhaging, infection, fetal injury, miscarriage and trauma of difficult family-planning decisions.

LUMBAR PUNCTURE

INTRODUCTION

The first lumbar puncture (LP) was performed by Quincke in 1891 to relieve increased intracranial pressure in children with meningitis [23]. This is a procedure to collect cerebrospinal fluid
to check for the presence of disease or injury. Knowledge about the proper indications, contraindications, various techniques, equipment, and recognition and treatment of its complications is vital to any physician that performs this procedure.

TECHNIQUE

A lumbar puncture technique require a standard commercial kit which contains spinal puncture tray, sterile gloves, manometer, three-way stopcock, sterile dressing, antiseptic solution, sterile drape, 1% Lidocaine, 3-cc syringe, 20 and 25 gauge needle, 20 and 22 gauge spinal needle and four plastic test tubes.

![Fig3. Lumbar puncture kit](image)

![Fig4. Flow chart showing steps of lumbar puncture](image)
It requires a patient either in the lateral recumbent position or sitting upright. The lateral recumbent position is preferred as it allows accurate measurement of the opening pressure. Firstly a CT- scan of the head is performed to check papilledema. Then the patient is allowed to lie in the correct position. L3, L4 and L5 spaces are located by moving the fingers medially from the crests to the spine to find the iliac crests and the palpation is used to identify the interspaces. The success in obtaining CSF is determined mainly by the correct patient positioning. The patient should remain in the fetal position with the neck, back, and limbs held in flexion. The patient’s back is prepared by cleaning the skin to remove dirt and debris. Povidone iodine is then applied in a circular motion and an area of at least 10 cm in diameter is prepared. Most kits include a solid drape and a fenestrated drape. The solid drape is then placed between the patient’s hip and bed whereas the fenestrated drape is placed with the adhesive side towards the patient’s back and the opening centered at the desired level for the procedure. Because of onset, efficacy, and potency supplied by chlorhexidine, many experts believe that it has an advantage over povidone-iodine [1,10,15,27,28]. The 25 gauge needle and 3cc needle is used to administer the 1% lidocaine intra-dermally. The spinal needle should be inserted slowly with the angle aiming towards the umbilicus. The needle should be spread by positioning the flat surface of the bevel to face the patient's flanks. The doctors choose to insert the needle incrementally and periodically removing the stylet to check for CSF flow, then reinserting the stylet until the subarachnoid space is entered [6]. A soon as CSF starts entering the needle hub, the patient is instructed to slowly straighten or extend the legs to allow free flow of CSF within the subarachnoid space. Along with this a manometer is placed over the hub of the needle to measure the opening pressure. Plastic tubes are the used to collect the fluid. When special studies including cytology or cultures for organisms that grow less readily (eg - fungi or mycobacteria) is done, 40 mL of fluid can safely be removed. Aspiration of CSF should not be attempted as it may increase the risk of bleeding [6].

CSF interpretation

The physician who performs the lumbar puncture should have an efficient skill of excellent interpretation of the CSF. It includes CSF pressure, cell counts and differential, glucose levels, protein levels. The Gram’s stain is a very reliable test when performed by properly trained individuals. In general, it is positive in identifying approximately 80 percent of bacterial CNS infections. The probability of detecting bacteria on a Gram’s stain depends upon the number of bacteria present in the CSF. Approximately 25 percent of smears are positive with 103 colony-forming units (CFU)/mL, 60 percent with 103 to 105 CFU/mL, and 97 percent with 105 CFU/mL. False negatives can result from partially treated meningitis where the sensitivity decreases to about 60 percent. False positives can result from the use of contaminated lumbar puncture trays or reagents, or the use of an un-occluded spinal needle. CSF cultures should be obtained in all patients suspected of having meningitis. Positive cultures are assumed to be 100 percent specific but may only occur in 80 percent of patients thought to have bacterial meningitis. Transportation of CSF specimens to the laboratory should be done fast and with great care as H. influenza and meningococcus cannot tolerate variations in temperature [18].

ADVANCES

The advancement in the technique allows the usage of medical simulator with lumbar puncture. These are developed with the highest quality, durability, and accuracy. They provide nursing and medical students with the most true-to-life training in physical examination and procedural skills. The advancement has also occurred in the utilization of imaging techniques such as CT-scan and MRI before the lumbar puncture so as to check papilledema.
COMPLICATIONS AND SIDE EFFECTS

The lumbar puncture can cause different types of problems which include raised intracranial pressure, thrombocytopenia and other bleeding diathesis. Not only this, it can even cause spinal epidural abscess. Afterwards it can also cause headache, infection, bleeding, cerebral herniation, minor neurologic symptoms such as radicular pain or numbness and late onset of epidermoid tumors of the thecal sac.

BIOPSY

INTRODUCTION

Biopsy can be defined as the extraction of cells or tissues from the patient body for examination. It is well known for the determination of disease presence and its extent in the patient body. It is thus widely used for different types of cancer diagnosis. The extracted tissues or cells are analyzed in all manners by the pathologist for diagnosis. The biopsy can be classified into subtypes which are excisional biopsy, incisional biopsy and needle aspiration biopsy. The usage of imaging techniques (MRI, CT Scan, etc) do not provide the surety of presence and extent of the disease due to which biopsy has gain its importance in diagnostic field.

NEED FOR BIOPSIES

Biopsies are preferred when other techniques are not able to provide the surety in diagnosis. This technique is mainly used for detecting cancer. In other words when other technique just indicate the possibility of a disease, biopsy is used to make it sure. Few examples are cited as follows -If a mammogram indicates a lump or mass, there is a possibility of breast cancer and if a mole is getting deformed the there is a danger of melanoma. Biopsy not only diagnoses the disease but also helps in determining the best therapy for it.

BIOPSY SITES

Bone marrow, gastrointestinal tract, lung, liver and kidney are considered as the sites which are safe for biopsy. Bone marrow biopsies are majorly used for the diagnosis of blood cells abnormalities which include blood cancer (lymphoma and leukemia). Its procedure involves the usage of trabecular bone core and then eluting the material from it. The lung biopsy is performed at many different locations of the lung according to the need. The gastrointestinal biopsy provides information about the digestive tract starting from esophagus to intestine via stomach. Endoscopy usage enables this visualization and then the biopsy can be performed at the specific site. For the pancreas needle core biopsies is done through the duodenum or stomach. This technique is of no usage for diagnosis in liver diseases such as hepatitis. On the other hand it is utilized for the visualization of extent of disease by looking into the degree of fibrosis.
Types of biopsies
- **Needle biopsy** - This is the major technique of biopsy in which a needle is used to draw a fluid or sample lump for analyses.
- **CT-guided biopsy** - In this doctor performs biopsy under the visual guidance of CT scan to determine the biopsy area.
- **Ultrasound-based biopsy** - In this an ultrasound scanner is used to insert the needle in the correct direction and position.
- **Aspiration biopsy** - A needle withdraws material from the mass. It is also called as fine needle aspiration.
- **Surgical biopsy** - This is used for the tissues which are hard to reach. In this the surgery is performed and either a small piece of tissue or the whole tissue is removed for the further diagnosis.

**TECHNIQUE**

Needle biopsy is one of the common types of biopsy. This type of biopsy is performed along with the local anesthesia. In this a needle is injected to the body part (Eg: breast) with the help of a scalpel and the cells are collected for further assessment in the laboratory by the pathologist. The other type of biopsy is surgical biopsy which includes excisional biopsy. It takes lots of time but is more accurate than the needle biopsy. In this entire lump of cancerous tissue is taken out for laboratory studies. This removal also includes some of the normal tissue surrounding the cancerous tissue to have the differentiation among both. This technique changes the look of the organ as in case of breast examination.

**ANALYSIS OF BIOPSED MATERIAL**

The biopsied material is sent to the laboratory for further analyses. Pathologist prepares the slide by taking the extremely fine section of the tissue and the remaining tissue is preserved for further studies if required. This slide is then fixed by the chemicals and is treated with different types of dyes to stain the sample for better and distinct visualization. This prepared slide is then visualized under the microscope by a skilled pathologist to diagnose the disease or its extent. The results are then copied into a file and a report is prepared about the findings.
Fig 6. M-scan of moving and stationary target

ADVANCES

Lots of advancements have taken place which has merged the biopsy with imaging techniques. SLN biopsy is one of the examples which are gaining importance in early detection of breast cancer. It tells clearly about the metastasis in the starting stage and the tumor cells which are small and isolated in the body can also be detected. The other advancement has taken place in case of combining the principle of Raman spectroscopy with biopsy. Raman spectroscopy provides clear and noise free contrast of images which helps in detecting brain tumor with high efficiency.

SIDE EFFECTS OF BIOPSIES

Pain is considered as the most common side effect of biopsy. It can also cause skin infections at the entry site of the needle or knife. These skin infections can be localized or can even spread. The other side effect is internal and external bleeding. The other side effects are specific to the area of biopsy. For example- If it is prostrate biopsy it can cause blood in urine, stool and sperm. Biopsy does not have any long term side effects.

ULTRASOUND

INTRODUCTION

Ultrasound is sonic energy at frequency above the audible range i.e. greater than 20 kHz. It exists as alternate compressions and rarefactions. Its behaviour also depends on the frequency of the sonic energy and the density and mechanical compliance of the medium. In diagnostic applications, ultrasound can be focussed into a beam and obeys the laws of reflection and refraction [3].

The reflected amount depends on refractive index of medium. At interface of extreme difference in media, as in tissue and bone or tissue and gas, almost all energy will be reflected therefore practically none will continue through the second medium. So, the propagation path should not include bone or any gaseous medium, such as air. An airless contact is produced through use of an aqueous gel or a water bag between the transducer and the skin.
Modes of transmission most commonly used in diagnosis medical applications are-
1. Pulsed ultrasound
2. Continuous Doppler
3. Pulsed Doppler
4. Range- gated pulsed Doppler

The ultrasonic images of internal organs provide valuable information regarding the size, location, displacement, or velocity of a given structure without the necessity of surgery or use of harmful radiations. After amplification, the received information is displayed in one of the several display modes-

1. A- scan display
2. M- scan display
3. B- scan display

1. A-scan display- it is the simplest display in which each transmitted pulse and returning echoes forms vertical deflections. The sweep formed by transmitted pulse displayed in unit of distance and gives information about distance of the interested interface. The amplifier is used to amplify the low intensity amplitude of distant echoes. Any movement in the target can be traced by using stationary transducer. An example for A-scan display is echo-encephalogram.

2. M-scan display- like A-scan display transmitted pulse triggers oscilloscope but here they received pulses are used to brighten the trance. A brightness threshold is set and the echo within range is displayed. Here also like A-scan, the transducer kept stationary and movement in target is traced by movement of dots along the sweep.

A stationary target appear as straight line while a moving one trace the pattern of its movement with respect to time. A light-pen recorder is used to produce a chart record of the movement of echoes with respect to time. M-scan display is used for echocardiogram.

3. B-scan display- It is used to produce two-dimensional image of stationary organs or body structure. Here the transducer moved with respect to the body and the vertical deflections of oscilloscope and chart paper move in correspond to transducer. The movement may be linear, circular or combination of both. B-scan display is used in the ultrasound of eye.

ULTRASONIC DIAGNOSIS

The ultrasonic methods are used in various fields like in cardiology, for abdominal imaging, in brain studies, in eye- analysis and in obstetrics and gynaecology.

The basic ultrasonic system consists of a generator for the electric signal, a transducer, the necessary amplifiers and other electronic processing devices and display unit.

ECHOCARDIOGRAPHY

Sound waves are used to produce image of a functional heart. It utilizes the M-scan technique [5]. In the echocardiogram the movements of the valves and other structures of the heart and displayed as a function of time. It has been extremely useful in diagnosing many cardiac abnormalities like congenital heart disease, infection in the sac around the heart, the source of blood clot after a stroke, rheumatic heart disease.

With ultrasound it is possible to distinguish between different soft tissues and to measure motion and structures of the heart. The heart has acoustic interfaces, such as atrial and ventricular walls, the septum, and the valves. The position and movements of each interface can be measured by the ultrasound.
ECHOENCEPHALOGRAPHY

Echoencephalography has been used to study cranial contents. Location of the mid-line of the brain can be determined by using A-scan mode of display. The transducer is held against the side of head to measure the distance of the midline of the brain. The midline echoes from both sides of the head are simultaneously displayed on the oscilloscope. One side producing upward deflection of the beam and the other produces downward deflection. In normal brain these two deflections line up, indicating equal distance from the midline to each side of the head. Non-alignment of these deflections indicates the possibility of a tumour or some other disorders that might cause the midline of the brain to shift from its normal position [24].

OPHTHALMIC SCANS

A major use of ocular echography is to examine the back of the eye in patients who have cloudy ocular media, such as cataract, corneal clouding, or blood in the vitreous fluid. One of the most frequent indications for ocular echography is to examine the retina in diabetic patients who have developed vitreous haemorrhage, to determine whether they have developed a potentially blinding condition called a retinal detachment.

A-scan echography is also frequently used by ophthalmologists to precisely measure the length on an eye prior to cataract surgery, to determine the strength of the lens implant to be placed in the eye at the time of cataract surgery.

Ultrasonography is used in diagnosing orbital thyroid ophthalmopathy which is also called Graves ophthalmopathy is a disease of orbital and peri-orbital tissue and thyroid gland. It is diagnosed by imaging enlargement of muscle belly and extra ocular muscles but the visualisation of orbital apex is difficult, therefore CT-Scan or MRI imaging is preferred for better visualisation and confirmation because some time orbital myositis which is an inflammation involving extra ocular muscle are confused with images of thyroid ophthalmopathy[3].

OBSTETRIC ULTRASONOGRAPHY

A Pregnancy ultrasound is an imaging test that uses sound waves to see how baby is developing in the womb. It is suggested to check the normal growth of baby and checking the chance of birth defects, ectopic pregnancy, multiple pregnancies, miscarriage, problems with the baby’s position in the womb, problems with placenta and tumours of pregnancy, other problems of ovaries, uterus and remaining pelvic structures. The ultrasound technique for examining the baby is safe and there is no documented risk to women or their developing babies. Ultrasound diagnosis is very safe as there is no use of any radiation. It is of low cost and can be used for first test in many disease but still it have some disadvantage like it is heavily operator-dependent. If a person is unable to diagnose the disease then it is worthless. It also gives picture in one orientation only.
MAGNETIC RESONANCE IMAGING

INTRODUCTION

Magnetic resonance imaging (MRI) is an imaging technique used primarily in medical settings to produce high quality images of the human body. It is based on the principles of nuclear magnetic resonance (NMR) and the combined use of magnetic field, radio waves and a particular character of hydrogen atom which are present in all tissues of the body. The nuclei of H atoms spin like tops, in random directions. When MRI is done, nuclear spins of all the hydrogen atoms become oriented in a single direction. The torque produces a change in angular momentum so it produces precession.

Protons with same mass precess at same frequency in uniform magnetic field. This is called Larmor frequency which is, \( f = \gamma B \) where:
- \( f \) = frequency of rotation
- \( \gamma \) = Larmor constant
- \( B \) = magnetic field strength.

For proton the value of \( \gamma \) is 42.58 million of cycle per Tesla i.e. in 1 Tesla, proton will precess at a rate of 42.58 million cycle per second. If a second field \( B_1 \) applied in perpendicular to \( B_0 \), the proton tends to precess with \( B_1 \). The rotation depends on the strength of \( B_1 \). Again on removal of \( B_1 \), the proton returns to their original lower energy configuration in Z axis. This relaxation is measured in MRI. The processed frequency is in radio range so it is called Radio signal or RF signals. The excitation proton tends to transfer energy from higher energy transverse plane to lower energy longitudinal plane. This requires collision between protons. So, the free water with lesser inter molecular interaction required more energy for collision in comparison to bound water. Bound water relaxes faster. T1 value is a factor which depends on material characteristic. T1 is the time required to reach 63% magnetization. The magnetic recovery depends on T1. T1 for human body = 0.1 to 4.0 sec. IV contrast like Gd-DTPA (gadolinium-diethylene triamine penta-acetate) decreases T1 value. Bounded water has higher T1 value than free water. A tissue sample having different T1 values portions, relaxes differently i.e. portion with less T1 value will relaxes faster. For high T1 value tissue MR signal produces darker image e.g. vertebrae looks lighter colour than spinal fluid in MRI. The radio signals or MRI signals undergo Fourier transformation and splits into constitutes in curves each curve have unique frequency computer generates picture.

MRI OF BRAIN

For MRI examination of brain patient is placed in supine position. Brain MRI can be used to diagnose and monitor many diseases and disorders that affect the brain, like Birth defect of the brain, Brain infection, Brain tumours, Multiple sclerosis, Stroke, mild cognitive impairment, Alzheimer's disease, bleeding in the brain.

The appropriate imaging plane is decided e.g. for multiple sclerosis sagittal plane, for lesion within corpus callosum, sagittal or coronal sections. Standard sequences which is an ordered combination of RF and gradient pulses designed to acquire the data to form the image are FLAIR, FLAIR + Gd, PD/T2/DwI/ADC, SWI, TOF MRA, Fat-Sat T2, STIR etc. Black holes in multiple sclerosis which is a persistent TI-hypointense lesion which is a marker of axonal loss and neuronal destruction can be imaged and diagnosed by MRI.
MRI in pregnancy

Intestinal obstruction in pregnancy is rare and difficult to diagnose. Common causes of gestational intestinal obstruction include adhesions, volvulus, intussusception, carcinoma, hernia and appendicitis. Acute abdomen [36] in pregnancy remains one of the most challenging diagnostic problems today. MRI and Ultrasound study is correlated for surgical management. The abdominal pain due to appendicitis can’t be confirmed by ultrasound imaging but it is confirmed by MRI scan. This case can be misdiagnosed by ultrasound imaging. MR is an accurate investigation in detecting the cause of acute abdominal and pelvic pain during pregnancy. Abdominal pain is a common feature, but the displacement of abdominal organs as pregnancy progresses results in atypical location of the pain and hence delays in diagnosis.

Technical development in MRI used in fetal imaging. The image artefact caused by fetal motion and hence the difficulty in study of fetal anatomy especially thorax, brain, abdomen, pelvis has been possible. It can be visualized as early as 18 weeks. Beside neurological studies MRI is also used to study fetal anatomy like lungs, liver, neck masses, urogenital abnormalities and chest abnormalities.

MRI is also used in maternal diagnosis to evaluate conditions like tumours, condition and functionality of placenta, amniotic fluid volumes and maternal cerebral blood flow changes. MRI is second tool after ultrasound for imaging because of its cost, complexity and availability.

MRI in eye disease

MRI scan is done to diagnose and confirm eye disease e.g. thyroid ophthalmopathy [29]. In the beginning contrast dye is injected into the vein and allowed to reach eye’s blood vessels. To diagnose thyroid ophthalmopathy disease serum TSH level is checked which is low in hyperthyroidism. Orbital ultrasound fails to diagnose the complexity in optic nerve which is imaged by MRI. It provides a full confidence result for disease diagnosis and requires no further conformation tests.

WHOLE BODY MRI

Whole body MRI is done to detect skeletal metastasis which is a major orthopaedic complication of failed cancer treatment [32]. Whole body MRI is an alternative to skeletal scintigraphy in which phosphates or di phosphates labelled with technetium 99m is used. The abundant of proton in the matrix tumour is the basis of MRI. Whole body MRI also detects spine and pelvis lesion. It allows simultaneous evaluation of soft tissue organs. It facilitates to access the total tumour burden particularly the patient with tumour spread all over the body. Whole body MRI is also helpful in fat measurement and a diagnostic tool in patient of polymyositis.

Sickle cell disease cause musculo-skeletal problems mostly as bone pain, expansion of bone marrow cavity dactylitis, avascular necrosis of head of femur, osteomyetitis, retarded growth and leg ulcer.
LIMITATIONS

MRI is an advanced imaging technique for disease diagnosis but it has some limitations also. It fails to distinguish between painful abnormalities and painless abnormalities. It cannot discriminate between functional or non-functional abnormal tissue.

The static magnetic field of up to 2 tesla did not show any biological effect on cell growth or morphology. There is no risk of leukaemia or other cancer reported due to MRI scan but some reversible effect like fatigue, headaches, hypotension, irritability may be seen after MRI scan.

The patient should not have any implantation like pacemaker, metal foreign bodies in eyes, cranial aneurysm clips etc., made up of ferromagnetic material.

MRI scan is done in a closed tunnel type heavy magnetic chamber. A patient is allowed to stay in the tunnel while scanning. It may take a long time complete the scanning, this may cause nervousness or discomfort to patient. This mental condition is called claustrophobia, which causes problem in medical diagnosis. So, modern MRI machines are equipped with certain modifications, like facilities of listening music, watching movies via head mounted display. It may have diagonal mirror placed in front of patient, to look outside the system. Sometimes chemical anaesthesia may also give to the patient. Because of the designing of the tunnel, a pregnant lady or obese person may feel discomfort in the machine.

ELECTROENCEPHALOGRAPHY

INTRODUCTION

Electroencephalography is a technique to read electrical signal from the scalp surface of the brain. It can be used for the patient of any age group like adults, children or old age person [34].

Neurons are connected with one another by synapsis. The message from one neuron to other neuron travelled in the form of weak electric current. These currents are mainly due to Na⁺, K⁺, Ca²⁺, Cl⁻ ions, which are pimped through the channels in the neuron. Large number of neurons produces a electrical signal which can be recorded. The weak electrical signals are amplified and then graphed on paper or stored in computer.

BRAIN WAVES

Brain electrical pulses from sinusoidal waves. The amplitude from peak to peak is 0.5 to 100 µV. it is amplified before plotting.

Brain waves have been categorised as –

- Beta wave - > 13 Hz
- Alpha wave – 8-13 Hz
- Theta wave – 4-8 Hz
- Delta wave – 0.5 – 4 Hz.
Alpha wave is the normal rhythm. It is observed better in posterior and occipital region. It is the situation of relaxation and closing of eyes.

Under normal condition of opened eye, beta waves are dominant. Delta waves appear in deep sleep.

**Uses of EEG**

EEG is a very fast technique. It is used for diagnosis of-
- Alertness, coma or brain death
- Area of damage
- Check anaesthetic depth
- Drug behaviour of brain
- Brain development
- Sleep disorder

Many neurological disease like epilepsy, tumour, cerebrovascular lesions and problems associated with trauma, are diagnosed by EEG.

**EEG recording techniques**

The encephalographic measurement requires following components-

1. Electrodes
2. Amplifiers with filters
3. A/D converter
4. Recording devices

1. Electrodes
For recording EEG, different type of electrodes are available like – needle electrode, Peel and stick electrode, silver plated cup electrode.

Pattern of electrode in the head and the channels is called montage. A reference electrode is generally placed on a non-active site such as the forehead or earlobe. EEG electrodes are arranged on the scalp according to a standard known as 10/20 system [12].

Head is divided into proportional distances from prominent landmarks like nesion, preauricular points, inion, which provides adequate coverage of all regions of the brain. Electrodes are named according to their position on the head. Like Fp – frontal – polar, F – frontal, C – central, P – parietal, T- temporal, O occipital. Odd number represents the electrodes on the left side of the head and even number represents the right one. Z represents the mid-line electrode. A new closely spaced electrode system has also been used nowadays. In this electrodes are spaced 5% distance along the cranium. For using electrodes, skin preparation differs accordingly. The skin is made oil free and cleaned with alcohol. Abrasive pastes are used with disc electrodes. In silver plated cup electrode, the left spaces are filled with conductive paste.

2. Amplifiers and filters
The weak signals should be amplified to make it compatible with the recording and displaying devices or A/D converter. Amplifiers have the ability to protect the signals from
damage through voltage and current surges. It rejects the superimposed noise and interference signals. The amplifier gain i.e. ratio of the output signal / input signal. For optimal signal quality adequate voltage should be 100 - 100,000. Analog filters are attached with amplification unit to reduce low frequencies changing from bioelectric flowing potentials like breathing.

3. A/D converter
The raw analog signal is converted into a digital format to make it readable by computer or storing device.

4. Recording devices
The data prepared by A/D converter have to be stored in recording device. The recording devices require large amount of memory to store the data, produced by EEG device. Some commercially available recording systems are- Lexicor, Electrical geodesics, Biosemi, NeuroScan, Sigma Medizin, Stellate, Thought Technology, Xltek.

**EEG in Brain disorders**

Epilepsy is a brain disorder which can be traced by EEG [11]. It is the uncontrolled excessive activity by either part or all of the central nervous system. The patient gets epilepsy when basal level of excitability of all or part of the nervous system rises above a certain threshold.

Epilepsy is mainly of two types-
2. Partial epilepsy – it involves a portion of brain.

Generalized epilepsy is of two types grand mal and petit mal epilepsy. Grand mal epilepsy is characterized by extreme discharge of neurons originating in the brain stem portion of reticular activating system, which regulates the arousal and sleep-wake transitions. The discharge is spread throughout the cortex, deep in the brain and even spinal cord also. It lasts for few seconds to 3-4 min. it results in convulsion to entire body. The patient’s body shakes rapidly and uncontrollably. The patient may become unconscious after the attack and it may be for 1 minute to as long as a day.

The grand mal epilepsy can be recorded from any region of the cortex. The discharge is same from both side of the brain. Petite mal epilepsy is brief epilepsy, lasting for 5-20 seconds. It occurs in two forms- myoclonic form and absence form. The EEG of petite mal epilepsy is typical spike and dome pattern.

In partial epilepsy involve almost any part of the brain. It may be caused due to scar on the neuronal tissue, a tumor that compresses an area in the brain area of the brain. The EEG of partial epilepsy is of low frequency between 2 and 4 Hz.
LIMITATIONS OF EEG

Although EEG is a very useful technique in disease diagnosis of brain but there are certain limitations. A false positive or negative result may be obtained due to patient or technical errors. The EEG signals can be distorted by any minor body movement, eye movement, sweat etc. technical factors like frequency 50/60 Hz., impedance, amount of electrode paste used battery condition of the machine etc. EEG fails to trace the brain disease like multiple sclerosis, stoke, Alzheimer’s disease, brain haemorrhage etc.

ELETROCARDIOGRAM

INTRODUCTION

Human heart is divided into four chambers as left and right auricle and ventricle. Sinusoidal node (SA node) serves as heart’s pacemaker, located in the wall of right atrium. It is the combination of both muscle and nerve. SA node tissue contracts like muscle and generates electric impulses like neurons system.

As the SA node contracts, a wave of excitation initiates, which travels through the wall of heart at a rate of approx. 1m/sec. The impulse spreads rapidly and the two atria contracts simultaneously. At the bottom of the wall separating two atria is another patch of nodal tissue, the atrioventricular (AV) node. The wave travelled to AV node by 0.1 sec. delay. This delay ensures the atrial contract before the ventricle.

ELECTRODES FOR ECG

The electrodes convert the ionic current within the body to electron current in the metal wires, which is then sent to recorder. Electrodes are made up of metals. The silver/silver-chloride electrode is most widely used.

Several types of electrodes used are - suction electrode, floating metal body-surface electrodes, dry electrodes.
ECG WAVES

The cardiac cycle produces electric current within the thorax. Voltage drop across the tissue can be detected by electrodes placed on the skin and recorded as electrocardiogram P,Q,R,S and T waves. The P wave shows- contraction of the atria, R wave or QRS complex shows the contraction of the ventricals, T waves represents repolarization of the ventricles. The atrial repolarization is covered in QRS complex.

The ECG recorded is amplified and converted from analog to digital signals. With several algorithms in microprocessor, the signal is displayed on the screen of microcomputer or print a hard copy of ECG signals for further analysis.

Different pairs of electrodes at different locations generally yield different results because of the spatial dependence of the electric field of the heart. Several surface electrodes are attached to patient body at different locations like- right arm, left arm, right leg and left leg. The combinations of the electrode is called lead.

ADVANCES IN ECG

An ambulatory monitor called Holter monitor, used to monitor heart abnormalities continuously. The electrodes are placed on the chest. The recordings helps the doctor to identify the rhythm and causes of abnormalities like chest pain, abnormal rapid pulsation of heart etc.

CONCLUSION

Diagnostic tools do not guarantee the curing of any disease but it can prevent the person from future havoc. Having the check up does not mean that the disease will be treated but it will provide better pathways for treatment. In conclusion, it is safe to say that choosing diagnosing tools is good for the society as it increases the number of healthy beings, prevents the patients from lifelong stress and trauma and help the doctors to better understand the disease. Hopefully, it will be a better outlook for others who are willing to go ahead and be much more intellectual about medicine technology and the rather amazing discoveries it can contribute to life.

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