FIVE BIOMEDICAL EQUIPMENTS

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1 Video Endoscope

1.1 What is Endoscopy?

An endoscopy is a procedure used to visually examine upper digestive system and the device used for this purpose is endoscope .During an endoscopy a medical practitioner gently inserts a long, flexible tube, or endoscope, into ones mouth, down the throat and into the esophagus.
A fiber-optic endoscope has a light and tiny camera at the end.A doctor can use this device to view a person esophagus, stomach and the beginning of small intestine. The images are viewed on a video monitor in the exam room. If a doctor sees anything unusual, such as polyps or cancer, he or she passes special surgical tools through the endoscope to remove tissue or collect a sample to examine it more closely.
Here are some key points about endoscopy:
• The first endoscope was designed in 1806.
• The main reasons for endoscopy are investigation, confirmation, and treatment.
• Endoscopy can be used to remove tumors or polyps from the digestive tract.

1.2 Uses of Video Endoscopy

Endoscopy is useful for investigating many systems within the human body; these areas include:
• Gastrointestinal tract: esophagus, stomach, and duodenum (esophagogastroduodenoscopy), small intestine (enteroscopy), large intestine/colon (colonoscopy, sigmoidoscopy), bile duct, rectum (rectoscopy), and anus (anoscopy).
• Respiratory tract: Nose (rhinoscopy), lower respiratory tract (bronchoscopy).
• Urinary tract: Cystoscopy
• Female reproductive tract (gynoscopy): Cervix (colposcopy), uterus (hysteroscopy), fallopian tubes (falloposcopy).
• Through a small incision: Abdominal or pelvic cavity (laparoscopy), interior of

a joint (arthroscopy), organs of the chest (thoracoscopy and mediastinoscopy).

1.3 Endoscope Use in Surgery

Endoscopes used in surgery help minimize bleeding and recovery times.
Endoscopy has advanced in recent years, enabling some forms of surgery to be conducted using a modified endoscope; this makes the surgery less invasive. Procedures such as the removal of the gallbladder, sealing and tying the fallopian tubes and the removal of small tumors from the digestive system or lungs are now commonplace. A laparoscope is a modified endoscope used for keyhole surgery (also referred to as laparoscopic surgery). Laparoscopic surgery requires only a small incision and can be used for appendectomies (removal of the appendix), hysterectomies (removal of the uterus) and prostatectomies (removal of prostate tissue). Using this technique, patients lose less blood during and after surgery and can recover much faster compared with standard surgical procedures.

1.4 Capsule Endoscopy-A recent development

Capsule endoscopy was developed in the mid-1990s and involves a wireless camera. The camera is small enough to fit into a capsule (roughly the size of a vitamin tablet) and can, therefore, be swallowed. As the capsule travels through the digestive tract, it takes thousands of pictures, which are transmitted to a device attached to a wearable belt. Capsule endoscopy is used to image the small intestine, a region that is difficult to image using standard endoscopy. It is also very useful for examining the small intestinal mucosa and diagnosing Crohn's disease.The capsule usually passes through the digestive system within 24-48 hours. This is a relatively new technique and was given FDA approval for use in the United States in 2001. To date, more than 500,000 capsule endoscopy

procedures have been carried out.
Nowadays the capsule is extracted from the body and the images are processed and cleaned in the cloud for the doctors to diagonise the problem early moreover the patient will not be required to wear a traditional transmission belt at all.

1.5 Recovery

Recovery will depend on the type of procedure. For an upper endoscopy, which is used to enable a doctor to examine the upper gastrointestinal tract, the patient will be observed for some time after the procedure, usually around one hour, while any sedative medication wears off. The person should not usually work or drive for the rest of the day, because of the sedative effect of the medication used to prevent the pain. There may be some soreness. With this type of endoscopy, there may be bloating and a sore throat, but these usually resolve quickly

2 EEG Machine

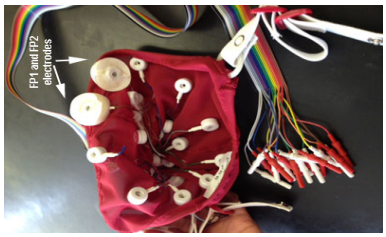
2.1 Introduction

The electroencephalogram (EEG) is a recording of the electrical activity of the brain from the scalp. The recorded waveforms reflect the cortical electrical activity.
Signal intensity: EEG activity is quite small, measured in microvolts (mV).
Signal frequency: the main frequencies of the human EEG waves are:
Delta: has a frequency of 3 Hz or below. It tends to be the highest in amplitude and the slowest waves. It is normal as the dominant rhythm in infants up to one year and in stages 3 and 4 of sleep. It may occur focally with subcortical lesions and in general distribution with diffuse lesions, metabolic encephalopathy hydrocephalus or deep midline lesions. It is usually most prominent frontally in adults (e.g. FIRDA - Frontal Intermittent Rhythmic Delta) and posteriorly in children e.g. OIRDA - Occipital Intermittent Rhythmic Delta).
Theta: has a frequency of 3.5 to 7.5 Hz and is classified as "slow" activity. It is perfectly normal in children up to 13 years and in sleep but abnormal in awake adults. It can be seen as a manifestation of focal subcortical lesions; it can also be seen in generalized distribution in diffuse disorders such as metabolic encephalopathy or some instances of hydrocephalus.
Alpha: has a frequency between 7.5 and 13 Hz. Is usually best seen in the posterior regions of the head on each side, being higher in amplitude on the dominant side. It appears when closing the eyes and relaxing, and disappears when opening the eyes or alerting by any mechanism (thinking, calculating). It is the major rhythm seen in normal relaxed adults. It is present during most of life especially after the thirteenth year.
Beta: beta activity is "fast" activity. It has a frequency of 14 and greater Hz. It is usually seen on both sides in symmetrical distribution and is most evident frontally. It is accentuated by sedative-hypnotic drugs especially the benzodiazepines and the barbiturates. It may be absent or reduced in areas of cortical damage. It is generally regarded as a normal rhythm. It is the dominant rhythm in patients who are alert or anxious or have their eyes open.

2.2 Recording of EEG

2.2.1 EEG Electrode

Small metal discs usually made of stainless steel, tin, gold or silver covered with a silver chloride coating. They are placed on the scalp in special positions. These positions are specified using the International 10/20 system. Each electrode site is labeled with a letter and a number. The letter refers to the area of brain underlying the electrode e.g. F- Frontal lobe and T - Temporal lobe. Even numbers denote the right side of head and odd numbers the left side of head.



EEG Cap

2.2.2 Electrode Gel

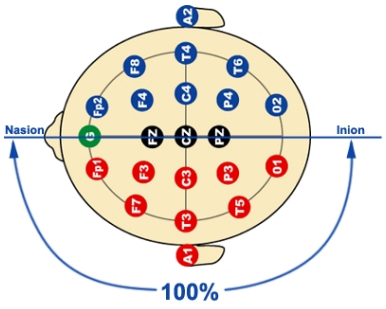
It acts as a malleable extension of the electrode, so that the movement of the electrodes cables is less likely to produce artifacts. The gel maximizes skin contact and allows for a low-resistance recording through the skin.

2.2.3 Impedence

A measure of the impediment to the flow of alternating current, measured in ohms at a given frequency. Larger numbers mean higher resistance to current flow. The higher the impedance of the electrode, the smaller the amplitude of the EEG signal. In EEG studies, impedence should be at lest 100Ω or less and no more than 5 $k\Omega$

2.2.4 Electrode Positioning

The standardized placement of scalp electrodes for a classical EEG recording has become common since the adoption of the 10/20 system. The essence of this system is the distance in percentages of the 10/20 range between Nasion-Inion and fixed points. These points are marked as the Frontal pole (Fp), Central (C), Parietal (P), occipital (O), and Temporal (T). The midline electrodes are marked with a subscript z, which stands for zero. The odd numbers are used as subscript for points over the left hemisphere, and even numbers over the right.



2.3 Artifacts

The biggest challenge with monitoring EEG is artifact recognition and elimination. There are patient related artifacts (e.g. movement, sweating, ECG, eye movements) and technical artifacts (50/60 Hz artifact, cable movements, electrode paste-related), which have to be handled differently. There are some tools for finding the artifacts. For example, FEMG and impedance measurements can be used for indicating contaminated signal. By looking at different parameters on a monitor, other interference may be found.

EEG Machine

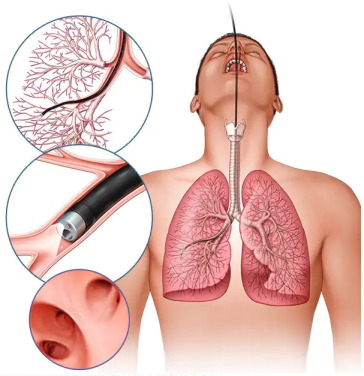
3 Bronchoscope

3.1 Overview

Bronchoscopy is a procedure that lets doctors look at your lungs and air passages. It's usually performed by a doctor who specializes in lung disorders (a pulmonologist). During bronchoscopy, a thin tube (bronchoscope) is passed through your nose or mouth, down your throat and into your lungs.
Bronchoscopy is most commonly performed using a flexible bronchoscope. However, in certain situations, such as if there's a lot of bleeding in your lungs or a large object is stuck in your airway, a rigid bronchoscope may be needed.
Common reasons for needing bronchoscopy are a persistent cough, infection or something unusual seen on a chest X-ray or other test.
Bronchoscopy can also be used to obtain samples of mucus or tissue, to remove foreign bodies or other blockages from the airways or lungs, or to provide treatment for lung problems

3.2 Why Its Done

Bronchoscopy is usually done to find the cause of a lung problem. For example, your doctor might refer you for bronchoscopy because you have a persistent cough or an abnormal chest X-ray.
Reasons for doing bronchoscopy include:
•Diagnosis of a lung problem
•Identification of a lung infection
•Biopsy of tissue from the lung
•Removal of mucus, a foreign body, or other obstruction in the airways or lungs, such as a tumor
•Placement of a small tube to hold open an airway (stent)
•Treatment of a lung problem (interventional bronchoscopy), such as bleeding, an abnormal narrowing of the airway (stricture) or a collapsed lung (pneumothorax)
During some procedures, special devices may be passed through the bronchoscope, such as a tool to obtain a biopsy, an electrocautery probe to control bleeding or a laser to reduce the size of an airway tumor. Special techniques are used to guide the collection of biopsies to ensure the desired area of the lung is sampled.
In people with lung cancer, a bronchoscope with a built-in ultrasound probe may be used to check the lymph nodes in the chest. This is called endobronchial ultrasound (EBUS) and helps doctors determine the appropriate treatment. EBUS may be used for other types of cancer to determine if the cancer has spread.

Fig.  BRONCHOSCOPY

3.3 Types Of Bronchoscope

Bronchoscope more or less like an endoscope(or infact a type of endoscope).Its can be of two types:
•Rigid
•Flexible

3.3.1 Rigid Bronchoscope

The rigid bronchoscope is a hollow metal tube used for inspecting the lower airway.It can be for either diagnostic or therapeutic reasons. Modern use is almost exclusively for therapeutic indications. Rigid bronchoscopy is used for retrieving foreign objects.Rigid bronchoscopy is useful for recovering inhaled foreign bodies because it allows for protection of the airway and controlling the foreign body during recovery.

Massive hemoptysis, defined as loss of over 600 mL of blood in 24 hours, is a medical emergency and should be addressed with initiation of intravenous fluids and examination with rigid bronchoscopy. The larger lumen of the rigid bronchoscope (versus the narrow lumen of the flexible bronchoscope) allows for therapeutic approaches such as electrocautery to help control the bleeding.

3.3.2 Flexible(fibreoptic) Bronchoscope

A flexible bronchoscope is longer and thinner than a rigid bronchoscope. It contains a fiberoptic system that transmits an image from the tip of the instrument to an eyepiece or video camera at the opposite end. Using Bowden cables connected to a lever at the hand piece, the tip of the instrument can be oriented, allowing the practitioner to navigate the instrument into individual lobar or segmental bronchi. Most flexible bronchoscopes also include a channel for suctioning or instrumentation, but these are significantly smaller than those

in a rigid bronchoscope.

Flexible bronchoscopy causes less discomfort for the patient than rigid bronchoscopy, and the procedure can be performed easily and safely under moderate sedation. It is the technique of choice nowadays for most bronchoscopic procedures.

3.4 Procedure of Bronchoscopy

Bronchoscopy can be performed in a special room designated for such procedures, operating room, intensive care unit, or other location with resources for the management of airway emergencies. The patient will often be given antianxiety and antisecretory medications (to prevent oral secretions from obstructing the view), generally atropine, and sometimes an analgesic such as morphine. During the procedure, sedatives such as midazolam or propofol may be used. A local anesthetic is often given to anesthetize the mucous membranes of the pharynx, larynx, and trachea. The patient is monitored during the procedure with periodic blood pressure checks, continuous ECG monitoring of the heart, and pulse oximetry.

A flexible bronchoscope is inserted with the patient in a sitting or supine position. Once the bronchoscope is inserted into the upper airway, the vocal cords are inspected. The instrument is advanced to the trachea and further down into the bronchial system and each area is inspected as the bronchoscope passes. If an abnormality is discovered, it may be sampled using a brush, a needle, or forceps. Specimen of lung tissue (transbronchial biopsy) may be sampled using a real-time X-ray (fluoroscopy) or an electromagnetic tracking system.[10] Flexible bronchoscopy can also be performed on intubated patients, such as patients in intensive care. In this case, the instrument is inserted through an adapter connected to the tracheal tube.

Rigid bronchoscopy is performed under general anesthesia. Rigid bronchoscopes are too large to allow parallel placement of other devices in the trachea; therefore the anesthesia apparatus is connected to the bronchoscope and the patient is ventilated through the bronchoscope.

4 Mammography Unit

4.1 Mammography

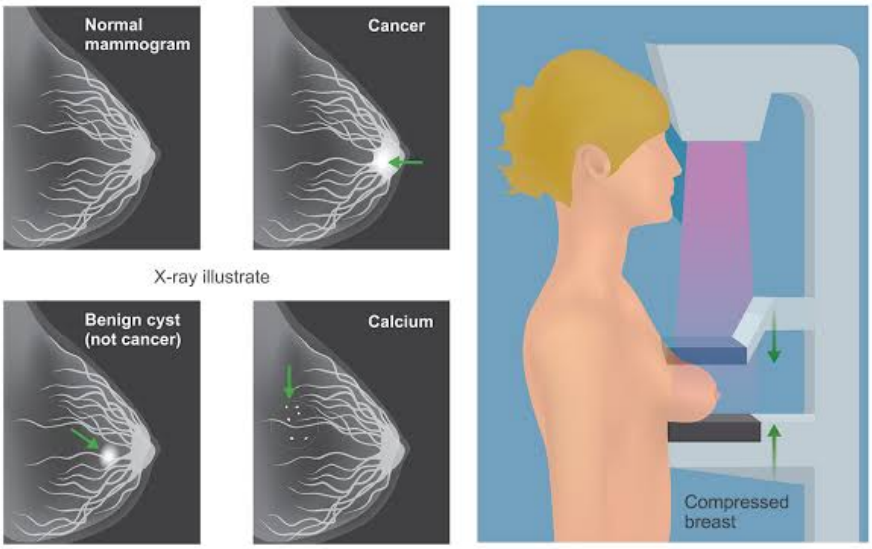
Mammography (also called mastography) is the process of using low-energy X-rays (usually around 30 kVp) to examine the human breast for diagnosis and screening. The goal of mammography is the early detection of breast cancer, typically through detection of characteristic masses or microcalcifications.
As with all X-rays, mammograms use doses of ionizing radiation to create images. These images are then analyzed for abnormal findings. It is usual to employ lower-energy X-rays, typically Mo (K-shell X-ray energies of 17.5 and 19.6 keV) and Rh (20.2 and 22.7 keV) than those used for radiography of bones. Ultrasound, ductography, positron emission mammography (PEM), and magnetic resonance imaging (MRI) are adjuncts to mammography. Ultrasound is typically used for further evaluation of masses found on mammography or palpable masses not seen on mammograms. Ductograms are still used in some institutions for evaluation of bloody nipple discharge when the mammogram is non-diagnostic. MRI can be useful for further evaluation of questionable findings, as well as for screening pre-surgical evaluation in patients with known breast cancer, in order to detect additional lesions that might change the surgical approach, for example, from breast-conserving lumpectomy to mastectomy. Mammography has a false-negative (missed cancer) rate of at least ten percent. This is partly due to dense tissue obscuring the cancer and the appearance of cancer on mammograms having a large overlap with the appearance of normal tissue.

4.2 Procedure

During the procedure, the breast is compressed using a dedicated mammography unit. Parallel-plate compression evens out the thickness of breast tissue to increase image quality by reducing the thickness of tissue that X-rays must penetrate, decreasing the amount of scattered radiation (scatter degrades image quality), reducing the required radiation dose, and holding the breast still (preventing motion blur). In screening mammography, both head-to-foot (craniocaudal, CC) view and angled side-view (mediolateral oblique, MLO) images of the breast are taken. Diagnostic mammography may include these and other views, including geometrically magnified and spot-compressed views of the particular area of concern. Deodorant, talcum powder or lotion may show up on the X-ray as calcium spots, so women are discouraged from applying them on the day of their exam. There are two types of mammogram studies: screening mammograms and diagnostic mammograms. Screening mammograms, consisting of four standard X-ray images, are performed yearly on patients who present with no symptoms. Diagnostic mammograms are reserved for patients with breast symptoms, changes, or abnormal findings seen on their screening mammograms. Diagnostic mammograms are also performed on patients with breast implants,

breast reductions, and patients with personal and/or family histories of breast cancer.

Until some years ago, mammography was typically performed with screen-film cassettes. Today, mammography is undergoing transition to digital detectors, known as digital mammography or Full Field Digital Mammography (FFDM). The first FFDM system was approved by the FDA in the U.S. in 2000. This progress is occurring some years later than in general radiology. This is due to several factors:
1.The higher spatial resolution demands of mammography
2.Significantly increased expense of the equipment
3.Concern by the FDA that digital mammography equipment demonstrate that it is at least as good as screen-film mammography at detecting breast cancers without increasing dose or the number of women recalled for further evaluation.



- In mammography, each breast is compressed horizontally.
- During a screening mammogram, the breast is placed between two plastic plates.
- The plates then are briefly compressed to flatten the breast tissue.
- Two views usually are taken of each breast.

4.3 Types Of Mammography

4.3.1 Digital

Digital mammography is a specialized form of mammography that uses digital receptors and computers instead of X-ray film to help examine breast tissue for breast cancer.The electrical signals can be read on computer screens, permit-

ting more manipulation of images to allow radiologists to view the results more clearly .Digital mammography may be "spot view", for breast biopsy,or "full field" (FFDM) for screening.
Digital mammography is also utilized in stereotactic biopsy. Breast biopsy may also be performed using a different modality, such as ultrasound or magnetic resonance imaging (MRI).

4.3.2 3-D Mammography

Three-dimensional mammography, also known as digital breast tomosynthesis (DBT), tomosynthesis, and 3D breast imaging, is a mammogram technology that creates a 3D image of the breast using X-rays. When used in addition to usual mammography, it results in more positive test.Another concern is that it more than doubles the radiation exposure.

4.3.3 Photon Counting

Photon-counting mammography was introduced commercially in 2003 and was shown to reduce the X-ray dose to the patient by approximately 40 percent compared to conventional methods while maintaining image quality at an equal or higher level.The technology was subsequently developed to enable spectral imaging with the possibility to further improve image quality, to distinguish between different tissue types,and to measure breast density.

4.3.4 Galactography

A galactography (or breast ductography) is a type of mammography used to visualize the milk ducts. Prior to the mammography itself, a radiopaque substance is injected into the duct system. This test is indicated when nipple discharge exists.

5 Transcranial Magnetic Stimulator

5.1 Overview

Transcranial magnetic stimulation (TMS) is a noninvasive procedure that uses magnetic fields to stimulate nerve cells in the brain to improve symptoms of depression. TMS is typically used when other depression treatments haven't been effective.

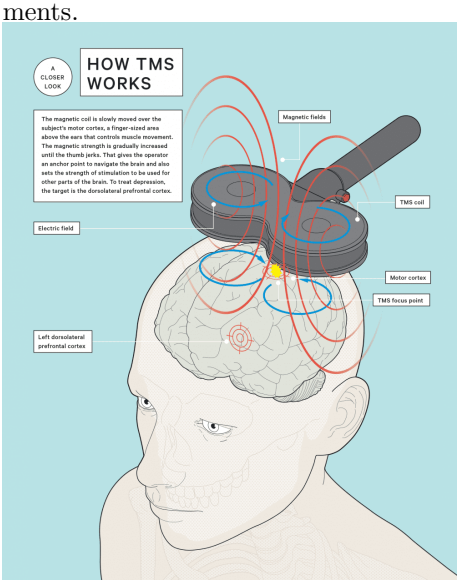
This treatment for depression involves delivering repetitive magnetic pulses, so it's called repetitive TMS or rTMS

5.2 How it Works

During an rTMS session, an electromagnetic coil is placed against your scalp near your forehead. The electromagnet painlessly delivers a magnetic pulse that stimulates nerve cells in the region of your brain involved in mood control and depression. It's thought to activate regions of the brain that have decreased activity in depression.

Though the biology of why rTMS works isn't completely understood, the stimulation appears to impact how the brain is working, which in turn seems to ease depression symptoms and improve mood.

There are different ways to perform the procedure, and techniques may change as experts learn more about the most effective ways to perform treatments.



5.3 Uses in Diagonosis

TMS can be used clinically to measure activity and function of specific brain circuits in humans, most commonly with single or paired magnetic pulses.The most widely accepted use is in measuring the connection between the primary motor cortex of the central nervous system and the peripheral nervous system to evaluate damage related to past or progressive neurological insult.

5.4 Adverse Effects

Although TMS is generally regarded as safe, risks are increased for therapeutic rTMS compared to single or paired diagnostic TMS. Adverse effects generally increase with higher frequency stimulation.

The greatest immediate risk from TMS is fainting, though this is uncommon. Seizures have been reported, but are rare.Other adverse effects include short term discomfort, pain, brief episodes of hypomania, cognitive change, hearing loss, impaired working memory, and the induction of electrical currents in implanted devices such as cardiac pacemakers.

5.5 Effects Of TMS

The effects of TMS can be divided based on frequency, duration and intensity (amplitude) of stimulation:
1) Single or paired pulse TMS causes neurons in the neocortex under the site of stimulation to depolarize and discharge an action potential. If used in the primary motor cortex, it produces muscle activity referred to as a motor evoked potential (MEP) which can be recorded on electromyography. If used on the occipital cortex, 'phosphenes' (flashes of light) might be perceived by the subject. In most other areas of the cortex, there is no conscious effect, but behaviour may be altered (e.g., slower reaction time on a cognitive task), or changes in brain activity may be detected using diagnostic equipment.
2) Repetitive TMS produces longer-lasting effects which persist past the period of stimulation. rTMS can increase or decrease the excitability of the corticospinal tract depending on the intensity of stimulation, coil orientation, and frequency. Low frequency rTMS with a stimulus frequency less than 1 Hz is believed to inhibit cortical firing while a stimulus frequency greater than 1 Hz, or high frequency, is believed to provoke it.Though its mechanism is not clear, it has been suggested as being due to a change in synaptic efficacy related to long-term potentiation (LTP) and long-term depression (LTD).

5.6 Other Neurolocical Uses

In the European Economic Area, various versions of Deep TMS H-coils have CE marking for Alzheimer's disease, autism,bipolar disorder,epilepsy,chronic

pain,major depressive disorder,Parkinson's disease,posttraumatic stress disorder (PTSD),schizophrenia (negative symptoms)and to aid smoking cessation.One review found tentative benefit for cognitive enhancement in healthy people.

In August 2018, the US Food and Drug Administration authorized the use of TMS in the treatment of obsessive-compulsive disorder (OCD).