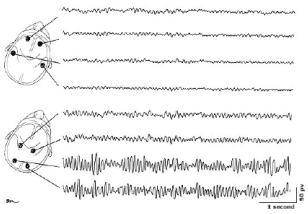
NERVOUS SYSTEM PHYSIOLOGY 3

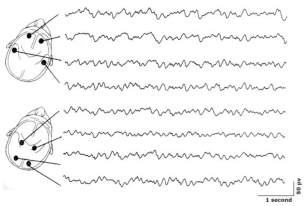
Electroencephalopathy is the recording of the spontaneous electrical activity of the brain. The electroencephalogram EEG records the summed electrical activity caused by dendritic postsynaptic potentials located in the superficial layer of the pyramidal cells in the outer cortex. The activity recorded at an individual scalp electrode represents averaged synaptic electrical activity within 20-25mm of the recording electrode. The signal is generated by something called a differential amplifier and the noise is removed by common mode rejection which basically subtracts the one signal from another removing the shared signals. Analysis is often a visual assessment of the relative frequencies, amplitude and symmetry which is an extremely important component of analysis, activity is usually symmetric about the midsagittal line.. There are three basic types of activity; continuous and rhythmical, transient and background activity. The frequency spectrum of the EEG is usually described in four bands, delta waves are the slowest 0-3 Hz, theta waves are 4-7 Hz, alpha waves, typical of an awake patient with eyes closed are 8-12 Hz, Beta waves are the fastest and representative of an awake and alert patient or someone in REM and are 13-30 Hz. More complex computation methods are also available often employing fourier analysis. The EEG is affected by both drugs and pathophysiological states. It is the former property that leads EEG to be used in anaesthesia to assess levels of sedation. Most general anaesthetics produce EEG excitation initially followed by progressive slowing. Deep sedation is often characterised by a shift in activity to the frontal regions, reduced variability, burst suppression or a silent EEG. Opiates do not appear to produce an initial excitement phase but produce a steady decline in EEG frequency, maintenance of amplitude in the delta range and without producing burst suppression or electrical silence. In addition to anaesthesia the EEG is affected by a range of physiological variables. Hypoxaemia, hypotension, hypocarbia, hypoglycaemia and ischaemia cause slowing and flattening of the the EEG. Hypercarbia produces excitation up to a point when the EEG becomes flat. Hypothermia produces slowing below 35 degrees and electrical silence at 7-20 degrees. The EEG is also dependent on age, with an adult pattern emerging at 10-15 years of age. Generalised encephalopathies of metabolic or infective origin present as a generalised excess of slow wave activity. Focal slow wave activity may be suggestive of a focal lesion such as a tumour. An abnormal discharge of high voltage is suggestive of a epileptiform disturbance.

Normal EEG in alert adult patient



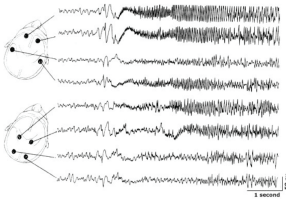
Demonstrates normal alpha waves in the posterior electrodes (will move frontal if patient closes eyes).

Generalised metabolic encephalopathy



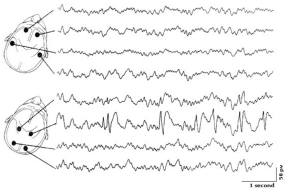
Slow wave (theta and beta) activty across all leads

Generalised tonic clonic seizure



Across all leads with high amplitude and frequency

Focal epileptic discharges



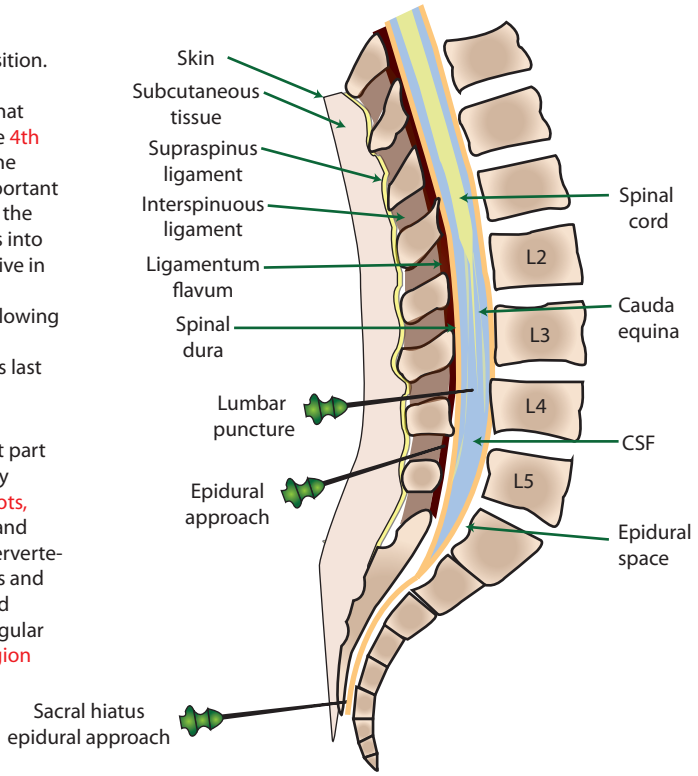
Spike and wave activity that is occurring in the right parietal region

Evoked Potentials Whereas the EEG is the measurement of spontaneous electrical activity in the cerebral cortex, evoked potentials EPs are produced in response to a deliberate stimulus involving specific neuronal tracts. They may be physiologic in nature such as light flashes to the eyes as in visual evoked potentials or nonphysiologic such as electrical pulses delivered to peripheral nerves in somatosensory evoked potentials. Because the the amplitude of sensory EPs is so small a technique known as signal averaging is used to resolve EPs from much greater EEG and ECG activity. Signal averaging involves repeatedly stimulating the nervous system and measuring the response during the period of stimulated neural activity. The waveforms are analysed for the amplitude (peak to trough) and the latency (delay from stimulus to wave appearance) of the characteristic waves. The waveforms are described as P (postive) or N (negative) by their latency after stimulation. Evoked potentials are classified according to the sensory pathway stimulated, visual-EPs, auditory-EP, braintem auditory EP, somatosensory EP, and motor EPs.

Nerve conduction studies Recording of the electrical response of a muscle to stimulation of its motor nerve at two or more points along its course permits conduction velocity to be determined in the fastest-conducting motor fibers between the points of stimulation. The latency and amplitude of the electrical response of muscle (i.e., of the compound muscle action potential) to stimulation of its motor nerve at a distal site are also compared with values defined in normal subjects. Sensory nerve conduction studies are performed by determining the conduction velocity and amplitude of action potentials in sensory fibers when these fibers are stimulated at one point and the responses are recorded at another point along the course of the nerve. In adults, conduction velocity in the arms is normally between 50 and 70 m/s, and in the legs is between 40 and 60 m/s. A loss of myelination or a reduction in diameter of axons will lead to an increase in latency.

Lumbar puncture is usually performed with the patient in the lateral of the sitting position. Whichever position is chosen, the patient should be asked to flex their lumbar spine to a maximal amount, thereby widening the spaces between the spinous processes. The line that joins the top of the illiac crests (the intercristal line) usually passes through the body of the 4th lumbar vertebrae and is therefore a useful landmark. The space above this line is usually the 3rd/4th interspace, immediately below this is the 4th/5th interspace. The interspace is important as the spinal needle should not be entered at a level which it may enter the spinal cord. In the adult, the spinal cord usually ends at the level of the 1st -2nd lumbar vertebra and divides into the cauda equina. Lumbar puncture is normally performed midline, although an alternative in the setting of a calcified supraspinus and interspinus ligament is a lateral or paramedian approach. After infiltration with local anaesthetic the spinal needle passes through the following structures shown in the diagram adjacent; the skin, subcutaneous tissue, the supraspinus ligament, the interspinus ligament, the ligamentum flavum and finally the dura mater. This last structure is classically described as producing a 'pop' as the needle enters the space.

The epidural (also known as the extradural or peridural) space in the spinal canal is that part not occupied by the dura and its contents. It extends from the foramen magnum to end by fusion of its lining membranes as the sacrococcygeal membrane. It contains fat, nerves roots, blood vessels and lymphatics. The posterior aspect of the space is limited by the laminae and overlying ligamentum flavum, laterally by the pedicles of the vertebral arches and the intervertebral spaces. The anterior structures are the bodies of the vertebrae, the intervertebral discs and the posterior longitudinal ligament. The epidural space can be entered by a needle passed either between the spinal laminae or via the sacral hiatus. The spinal canal is roughly triangular in cross section therefore the space is deepest in the midline posteriorly. In the lumbar region the distance between the laminae to the posterior aspect of the dura is about 5mm.



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