Spinal Cord Monitoring

Essay

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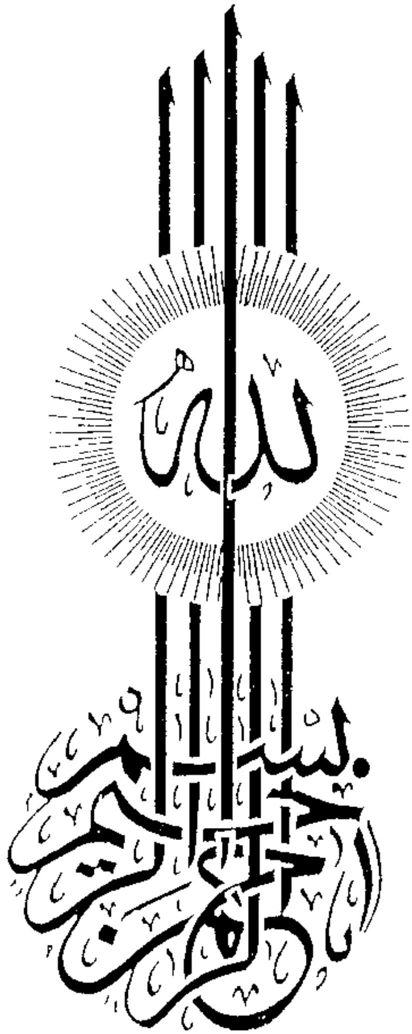
بسم الله الرحمن الرحيم

To My Father , Mother,
My Sisters.

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Introduction

Surgery for correction of spinal deformities such as scoliosis and kyphosis carries a small but significant risk of damage to the spinal cord through inadvertent compression or interference with the blood supply. As many of the patients undergoing such surgery are fit young children or adolescents, the consequences of post-operative paraplegia are catastrophic.

The recognition that some of these complications are potentially avoidable has led to the development of spinal cord monitoring. Today it is standard practice to conduct some form of monitoring when performing any spinal operation that is associated with a high risk of neurological injury.

Generally, operations are considered to carry such a risk when corrective forces are applied to the spine, the patient has pre-existing neurological damage, the cord is being invaded or an osteotomy or other procedure is being carried out in immediate juxta position to the spinal cord.

The so called gold standard is still the "wake-up test" which, when performed properly, is associated with little morbidity and is very helpful in revealing the status of the patient's motor function at the moment when it is performed.

More recently the term spinal cord monitoring is taken to mean neurophysiological monitoring of the spinal cord.

The development of neurophysiological monitoring of the spinal cord has depended on basic scientific observations of the phenomena of central nervous system electrical activity evoked by peripheral nerve stimulation.

There are several methods of neurophysiological monitoring. The most commonly used is the somato sensory evoked potential (S.S.E.P.) however selection of the anaesthetic technique is important as S.S.E.P. is affected by many anaesthetic drugs.

Monitoring of the motor evoked Potential (MEP) is another method, it is justified by the small, but definite, incidence, of anterior cord ischemia occurring without any change in S.E.P.

So MEP is an earlier predictor of impending cord damage than SEP however MEP is performed on a limited basis and it should be considered in high risk surgery.MEP is also affected by the anaesthetic drugs used. Although the anaesthetic contribution to intra operative monitoring of the spinal cord is considerable, it must be remembered that operative decisions made on the basis of spinal cord monitoring remains the responsibility of the surgeon.

FUNCTIONAL ANATOMY OF THE SPINAL CORD

Functional Anatomy of the Spinal Cord and Somatosensory Areas of the Cerebral Cortex

Functional Anatomy of the Spinal Cord

The spinal cord is a long cylindrical structure, invested by meninges, that lies in the vertebral canal. It extends from the foramen magnum, where it is continuous with the medulla, to the lower border of the first lumbar vertebra. Two enlargements of the spinal cord are recognized, cervical and lumbar, each associated with nerve roots that innervate, respectively, the upper and lower extremities.

The lower termination of the spinal cord is conical in shape, it is called the conus medullaris and occur at the level of the first lumbar vertebra. The spinal cord is devided by 31 pairs of spinal nerves into segments, these are 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal.

Each pair of spinal nerves has 2 roots, anterior and posterior. The anterior and posterior root of each pair unite in the inter vertebral foramen to form the main spinal nerve trunk that soon divides into anterior division and posterior division.

The lumbo sacral and coccygeal roots descend almost vertically along the vertebral canal before leaving it through the inter vertebral foramina to form the cauda equina. *(Carpenter 1983)*.

Internal Structure of The Spinal Cord:

In a transverse section, the spinal cord consists of a butterfly shaped central gray substance surrounded by a white matter. The gray matter is composed of a collection of cell bodies and their processes, the white matter is composed of bundles of myelinated fibers that are ascending or descending. Fiber bundles having the same origin, course and termination are known as tracts or funiculi. The white matter of the spinal cord is devided into three paired funiculi: the posterior, lateral and anterior. Each half of the gray matter is divided into an anterior horn, a posterior horn and a small horn in the thoracic spinal segments.

The Gray Matter:

The gray matter is composed of nerve cells (nuclei), unmyelinated nerve fibers and neuroglia. Its anterior horn in motor, its posterior horn is sensory while the lateral horn is autonomic.

The White Matter:

The white matter is composed of bundles of myelinated fibers that are either ascending or descending in three paired funiculi, the posterior, the lateral and anterior funiculus.

Ascending Tracts of the White Matter:

Posterior White Columns:

It is formed of heavily myelinated fibers arising from cells of the dorsal root ganglia at all levels of the spinal cord, they ascend in the posterior funiculus in a special arrangement so that sacral fibers are most medially and cervical fibers are most laterally. The posterior funiculus on each side is divided by a posterior intermediate septum into fasciculus gracilis (medial) and the fasciulus cuneatus (lateral). These fasciculi relay in the corresponding nuclei in the medulla oblongata. The posterior column convey impulses concerned with fine touch and propio-ceptive sensations such as muscle sense, joint sense, vibration sense and cortical sensations as tactile localization and two points discrimination. *(William and Wilkins 1983).*

Anterior Spinothalamic Tract:

The anterior spino thalamic tract arise from cells within the spinal cord. These are called the Substantia Gelatinosa of Rolandi. The axons of these cells cross to the opposite side and ascend within the anterior and the anterolateral funiculi of the spinal cord. These are arranged so that fibers arising from sacral and lumbar segments are most lateral while those arising from cervical and thoracic are most medial.

These fibers relay in corresponding nuclei at the Thalamus and they convey impulses concerned with light touch . *(Apkarian 1989).*

Lateral Spinothalamic Tract:

These have the same origin as the anterior spinothalamic tract but they ascend within the lateral funiclus of the spinal cord. They convey impulses concerned with pain and temperature.

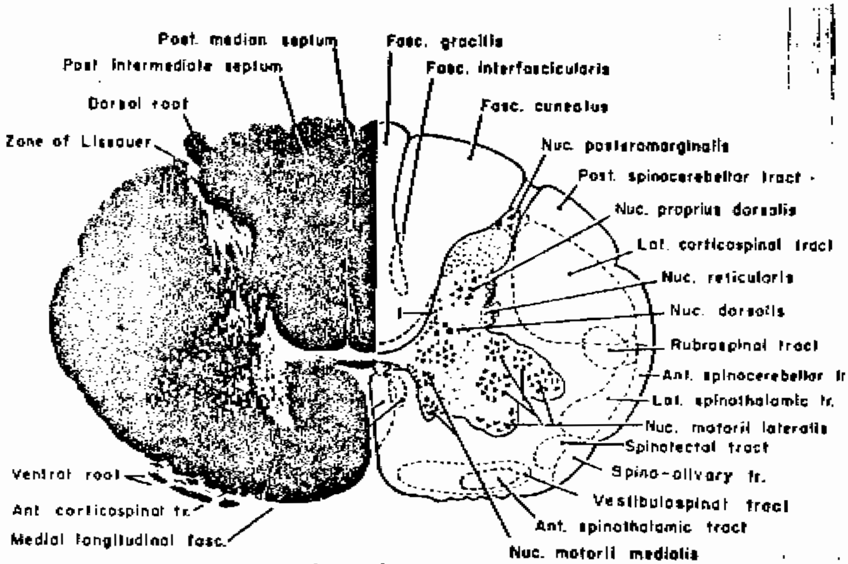
The Posterior Spino-Cerebellar Tract:

These arise from cells of the Clark nucleus within the gray matter and ascend in the lateral funiculus of the white matter to terminate at the cerebellum. It convey impulses concerned with the fine coordination of posture and movement of the individual limb muscles.

(Grant 1962).

The Anterior Spino-Cerebellar Tract:

These arise from cells of the lamina V , VI of the white matter and ascend in the lateral funiculus to terminate at the level of the cerebellum. It convey impulse concerned with the coordinated movement and posture of the entire lower limbs. *(Liu 1968).*



Ascending and descending tracts of the spinal cord

Core text of neuroanatomy 1983.

Diagram 1

The Descending Tracts of the White Matter:

The descending spinal tracts are concerned with somatic motor function, visceral innervation, the modification of muscle tone and central transmission of sensory impulses. The most important of these tracts arises from the cerebral cortex, all other tracts arise from cell groups within the brain stem.

The Cortico Spinal Tract:

These tracts consist of all fibers that arise from cells in the cerebral cortex, passing through the medullary pyramid and descending into the spinal cord. They arise from the motor area (area 4),