

BRAINSTEM CHANGES IN FATAL HEAD INJURIES

T H E S I S

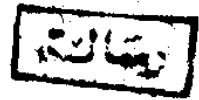
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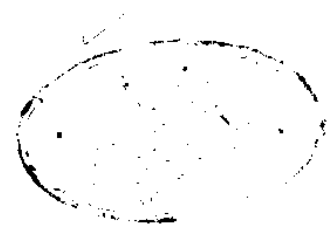
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(1986)

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

ويسألونك عن الروح قل الروح من أمر ربي وما أوتيتم
من العلم الا قليلا ..

صدق الله العظيم



**THIS IS DEDICATED TO MY MOTHER
AND
MEMORY OF MY FATHER**

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INTRODUCTION AND AIM OF THE WORK

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The large number of head injuries sustained in accidents impose increasing medical, economic and social problems through the world. Of critical importance in attempts to lighten this public health burden on our social structure is the acquisition of accurate data regarding the morbidity and mortality of head injuries.

Until recently there has been much confusion about the mortality rate of head injuries, due mostly to the lack of an accurate system of classifying patients and information. With such organization, knowledge of the frequency and severity of disability, number of fatalities, as well as the patients who have a good outcome give focus to the work of increasing survival without increasing the number of those who remain vegetative. Steven et al (1982).

The neurosurgeons who see the victims of this epidemic more than other branches of medicine have a great responsibility to make responsible people in the community to realise that as in any other epidemic, prevention is cheaper and easier than cure.

A careful study of the fatal cases may help to throw some light on the pathogenesis of head injuries.

It is generally believed that, under conditions of head trauma, the brainstem is the least likely area to be damaged. Nevertheless, haemorrhages in the brainstem are frequently observed in cases of head injury.

The brainstem or bulb is a mass of nervous tissue connecting the cerebral hemispheres with the spinal cord. It extends in life from just above the aperture in the tentorium cerebelli to the foramen magnum.

The brainstem lies nearly vertical in the body. It consists of **midbrain**, **pons** and **medulla oblongata**, and each of these three structures looks very different when viewed from the dorsal and ventral surfaces.

The brainstem consists of fibres and cells. Most of the fibres in the brainstem ascend or descend longitudinally, as in the spinal cord, and most of the cells are aggregated into nuclei.

These nuclei consist of three groups:

1. The nuclei of the cranial nerves III to XII .
2. Other named nuclei which are demonstrable, such as the colliculi, the red nucleus, the pontine nuclei and the olivary nucleus.
3. A number of physiological centres (in the medulla) in the region of the nuclei of the vagus. They constitute the cardiac, respiratory vasomotor, etc., centres Last(1979).

Aim of the Work

The aim of this work is to study the vessels of the base of the brain i.e. the circle of willis in cases with fatal head injury to detect any pathological changes in them.

The work will also undertake examination of the brainstem to scrutinise the integrity of the brainstem vessels and the cell population in some of its nuclei e.g: substantia nigra, cochlear and olivary nuclei. The fatal cases will include cases dying immediately after injury and also severely injured cases that succumbed days or weeks after head injury.

ANATOMY OF THE BRAINSTEM

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The Midbrain

The midbrain lies at what the hiatus in the tentorium cerebelli and connects pons and cerebellum with the forebrain. It is the shortest segment of the brainstem, being not more than 2 cm in length. On each side it is related to the parahippocampal gyrus, which hides its lateral aspect from view when the inferior surface of the brain is examined. Its long axis inclines ventrally as it ascends. (Williams & Warwick 1980).

The midbrain can for description be divided into right and left halves, the cerebral peduncles each of which is further subdivided into a ventral part, the crus cerebri, and a dorsal tegmental part, by lamina of pigmented grey matter, the substantia nigra. The two crura are separate, whereas the tegmental parts are united. The tegmentum is traversed by the cerebral aqueduct, which connects the third and fourth ventricles. The region of the tegmentum dorsal to the cerebral aqueduct is called the tectum and comprises the colliculi which consist of four rounded elevations, symmetrically arranged in superior and inferior pairs; these include visual and auditory reflex centres respectively. Williams & Warwick (1980).

The crura cerebri are two white, superficially corrugated structures which emerge from the cerebral hemispheres, one on each side of the median plane. They converge as they descend and meet where they enter the pons; here they form the posterior boundaries of the interpeduncular fossa. The surface of the posterior part of the interpeduncular fossa is formed by a greyish area, the posterior perforated substance, through which pass the central branches of the posterior cerebral artery., Williams & Warwick (1980).

The ventral surface of each crus is crossed close to the pons, from medial to lateral, by the superior cerebellar and posterior cerebral arteries; near to the point of entry of the crus into the cerebral hemisphere, the optic tract winds backwards around it. Over the surface of the crus, also close to the pons, in a thin white band, the tenia pontis, is frequently seen as it enters the cerebellum between the middle and superior peduncles, (Williams & Warwick, 1980).

The medial surface of each crus bears a longitudinal groove, the medial sulcus, from which the roots of the oculomotor nerve emerge. The lateral surface of each peduncle is in relation with the parahippocampal gyrus of the cerebral hemisphere and is crossed in a ventral direction by the trochlear nerve. This surface is marked by a longitudinal groove, the lateral sulcus; the fibres

of the lateral lemniscus come to the surface in this sulcus, and then turn dorsally, some to enter the inferior colliculus, the rest passing into the brachium of the inferior colliculus. Williams & Warwick (1980) .

The colliculi (corpora quadrigemina) are four rounded eminences, situated cranial to the superior medullary velum, caudal to the pineal gland and posterior commissure. The whole region inclining ventrally as it ascends. They are inferior to the splenium of the corpus callosum, and are partly overlapped on each side by the pulvinar of the thalamus. The colliculi are arranged in pairs (superior and inferior), and are separated from one another by a cruciform sulcus. The vertical part of this sulcus expands superiorly to form a slight depression in which the pineal gland lies. From the inferior end of the vertical sulcus a white ridge, the frenulum veli, is prolonged caudally to the superior medullary velum ; at the sides of this ridge the trochlear nerves emerge, pass ventrally on the lateral aspects of the cerebral peduncles and traverse the interpeduncular cistern to reach the posterior end of the cavernous sinus. The superior colliculi are larger and darker in colour than the inferior, and constitute centres for visual responses. The inferior colliculi, though smaller, are somewhat more prominent than the superior and are associated with the auditory pathway. The difference in colour is due to the greater accumulation of nerve cells near the surface of the superior colliculus Williams & Warwick(1980).

From the lateral aspect of each colliculus a ridge, termed the brachium ascends in a ventrolateral direction. The brachium of the superior colliculus passes inferior to the pulvinar. It partly overlaps the medial geniculate body and is partly continued into the lateral geniculate body, and partly into the optic tract. It conducts fibres from the retina and from the optic radiation to the superior colliculus. The brachium of the inferior colliculus ascends ventrally from the inferior colliculus; it conveys fibres from the lateral lemniscus and the inferior colliculus to the medial geniculate body. Williams and Warwick(1980).

The Pons :

The pons is ventral to the cerebellum, the midbrain is rostral to it, inferiorly the pons is continuous with the medulla oblongata, but is demarcated from it in front and on each side by a transverse furrow in which the abducent, facial and vestibulocochlear nerves appear. Williams & Warwick(1980).

The ventral or anterior surface of the pons is prominent, being markedly convex from side to side, less so from above downwards. It consists of transverse fibres arched like a bridge across the median plane, and converging on each side into a compact mass which forms the middle cerebellar peduncle. It adjoins the dorsum sellae of the sphenoid bone and the adjacent basilar part of the occipital bone, and is limited above and below by well defined borders. The anterior surface of the pons is marked by the shallow median sulcus basilaris, which usually lodges the basilar artery; this sulcus is bounded on each side by an eminence caused by the descent of the corticospinal fibres through the substance of the pons. Lateral to these eminences, a little above the mid level of the pons, the trigeminal nerves make their exit, each consisting of a smaller, superomedial motor root , and a larger inferolateral, sensory root; lies immediately lateral to the superficial origins of the trigeminal nerves, may be taken as arbitrary boundaries between the ventral surface of the pons and the middle cerebellar peduncles. The dorsal surface of the pons is hidden by the cerebellum. It contributes to the upper half of the rhomboid fossa. Williams & Warwick,(1980).

The Medulla Oblongata

Extends from the lower margin of the pons to a transverse plane corresponds with the upper border of the atlas behind, and the middle of the dens of the axis in front, at this level the medulla oblongata is continuous with the spinal cord. The internal structure of the spinal

cord changes gradually to that of the medulla oblongata. The anterior surface of the medulla oblongata is separated from the basilar part of the occipital bone and the upper part of the dens by the membranes of the brain and the occipito-axial ligaments. Posteriorly it is received into the notch between the hemispheres of the cerebellum, and the upper portion of this surface forms the lower part of the floor of the fourth ventricle. Williams & Warwick (1980).

The medulla oblongata is somewhat pyriform in shape, its broad extremity being directed upwards to merge with the pons, while its narrow lower end is continuous with the spinal cord. It measures about 3 cm longitudinally, 2 cm transversely at its widest part, and 1,25 cm antero-posteriorly. The central canal of the spinal cord is prolonged into its lower half, and then expands as the cavity of the fourth ventricle; the medulla oblongata may therefore be divided into a lower closed part containing the central canal, and an upper open part corresponding with the lower half of the fourth ventricle. Its anterior and posterior surfaces are marked by median fissures. Williams & Warwick (1980).

The anterior median fissure contains a shallow fold of pia mater, and extends along the entire length of the medulla oblongata; below, it is continuous with the anterior median fissure of the spinal cord; above, it ends at the lower border of the pons in a small triangular expansion termed the foramen caecum. Its lower part is interrupted by bundles of fibres which cross obliquely from one side to the other, the decussation of the pyramids. Some fibres, the anterior external arcuate fibres, emerge from the fissure above this decussation and curve laterally over the surface of the medulla oblongata. Williams & Warwick (1980). The posterior median sulcus is a narrow groove which exists only in the closed part of the medulla oblongata; it is continuous below with the posterior median sulcus of the spinal cord, but becomes rapidly shallower of cranial levels, and ends about the middle of the medulla oblongata, where the central canal expands into the cavity of the fourth ventricle. (Williams & Warwick, 1980).

Many of the cranial nerves emerge from or enter the substance of the medulla oblongata and they appear at the surface in line with the roots of spinal nerves. The fibres of the hypoglossal nerve correspond in position with ventral spinal roots and emerge in linear series from a furrow termed the anterolateral sulcus. Similarly, the accessory, vagus, and glossopharyngeal nerves are in line with dorsal spinal roots and enter or leave through the bottom of a sulcus named the posterolateral sulcus. Williams & Warwick,(1980). The olive is a smooth, oval elevation between the anterolateral and posterolateral sulci and lateral to the pyramid. It is caused by underlying groups of nerve cells forming the inferior olivary nuclei. It is lateral to the pyramid, separated by the anterolateral sulcus and the fibres of the hypoglossal nerve. It is about 1.25 cm long, and dorsolateral to its cranial end there is a slight depression at the lower border of the pons in which the roots of the facial nerve appear. The anterior external arcuate fibres emerge from the anterior median fissure, and wind backwards across the pyramid and the olive to enter the inferior cerebellar peduncle. Williams & Warwick (1980).

The Fourth Ventricle

The substance of the midbrain surrounds the aqueduct and the substance of the lower medulla surrounds the central canal. Between the two, the substance of pons and upper medulla lies ventral and the central canal is expanded into a cavity known as the fourth ventricle, which is roofed in by ependyma and pia mater. The roof is updrawn into a tent shape (the ridge-pole of the tent lying transversely) and is covered by the cerebellum. The upper part of the roof lies over the pons. The ependyma here is covered with a thin sheet of white matter called the superior medullary velum, which is bounded by the superior cerebellar peduncles.