INTRODUCTION

Stroke is defined as either symptoms lasting more than 24 hours or imaging of an acute clinically relevant brain lesion in patient with rapidly vanishing symptoms. Patients with symptoms lasting less than 24 hours but with infarction imaged by MRI have been reclassified as having stroke instead of transient ischemic attack ***(Chong et al., 2005).***

The association of hyperglycemia and brain injury had already been described by Claude Bernard in 1849, for a longtime, hyperglycemia was understood only as an epiphenomenon due to the stress of an acute injury. Its impact on the neurological recovery was ignored for a long time and the increase in blood glucose level was understood as an adaptive response to provide glucose for an exclusive glucose consuming tissue ***(Hamilton et al., 1995).***

Causes of hyperglycemia in critical ill patients include diabetes mellitus, stimulation of stress hormones (epinephrine, cortisol), glucocorticoid therapy, continuous enteral nutrition and decreased activity ***(Malhortra, 2006).***

Stress hyperglycemia is defined as a transient plasma glucose level above 200 mg/dL and it is thought to be caused by the increased levels of cortisol, glucagon, and epinephrine.

These hormones increase gluconeogenesis and decrease peripheral uptake of glucose to ensure substrate availability ***(Umpierrez et al., 2002).***

Hyperglycemia is of interest as it is associated with poor outcomes from acute hospital admission for other conditions. In a study of 2030 adults admitted to general hospital wards, newly discovered hyperglycemia (admission or fasting blood glucose >7 mmol/L or two random blood glucose measurements >11.1 mmol/L) was associated with higher in-hospital mortality (16%) than established diabetes mellitus (3%) or normal blood glucose (1.7%) ***(Umpierrez et al., 2002).***

A meta-analysis suggests that the relative risk of death in hyperglycemic non-diabetic stroke patients is increased by 3.3, recent analyses of both prospective and case control studies have confirmed the importance of acute hyperglycemia as a predictor of outcome after stroke ***(Capes et al., 2001).***

Scales that measure neurological deficits or specific body functions can be used especially well for triage and to guide acute-treatment decisions. The NIHSS, for example, is a valuable tool for initial assessments of patients with stroke in emergency departments, hospitals, or in the pre-hospital setting, and is predictive of subsequent resource use and long-term outcome ***(Schlegel et al., 2003).***

The role of clinicians in stroke management is not confined to treatment, and the confidence of the patient and family can be greatly enhanced by the ability to offer an accurate prognosis. A reliable prognosis allows better planning for supportive care, more accurate information to be given to relatives and resources to be allocated in a more efficient way ***(Liu et al., 2007).***

AIM OF THE WORK

The aim of the work is:

To study the effect of hyperglycemic status on the severity and prognosis of stroke in the intensive care unit.

Chapter (1)

ANATOMY AND BLOOD SUPPLY OF THE BRAIN

1- Anatomy of the Brain

The central nervous system (CNS) can be divided into brain and spinal cord. The brain, is contained within the cranium, and constitutes the upper, greatly expanded part of the central nervous system. The average weight of the brain, in the adult male, is about 1380 gm; that of the female, about 1250 gm (***Mendoza and Foundas, 2008).***

The brain is formed of:

1- The Cerebral Hemispheres (figure -1)

The cerebral hemispheres constitute the largest part of the brain. The hemispheres are separated medially by the longitudinal cerebral fissure. They are connected across the middle line by the corpus callosum. Each possesses a central cavity (the lateral ventricle) and presents three surfaces: lateral, medial, and inferior. These three surfaces are separated from each other by the borders: supero-medial, infero-lateral, medial occipital and medial orbital. The surfaces of the hemispheres are

moulded into a number of irregular eminences, named gyri or convolutions, and separated by furrows termed fissures or sulci. By means of these fissures and sulci, assisted by certain arbitrary lines, each hemisphere is divided into the following lobes: the frontal, the parietal, the temporal, and the occipital ***(Mendoz and Foundas, 2008).***

The left hemisphere contains the language centers in virtually all right-handed people and in more than 85 % of left handed people. The hemispheres that contain the language centers are referred to as the dominant hemisphere ***(John et al., 2008).***

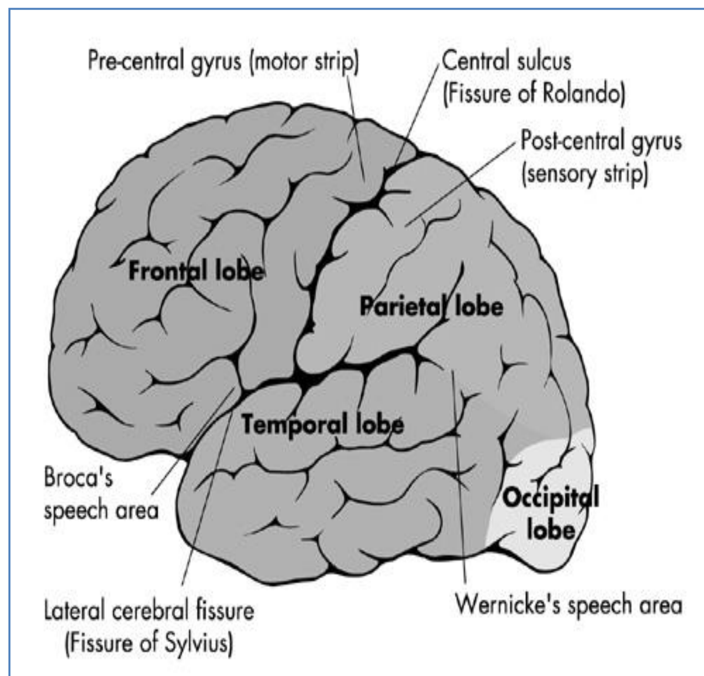

Fig. (1): The lobes of the brain ***(Fine, 2008).***

2- The Brain Stem

The brainstem is a small but extremely important structure, and has primarily three functions. Firstly, it is a conduit for transmitting signals back and forth from the cerebrum and cerebellum to the spinal cord. Secondly, the 12 cranial nerves and their nuclei are found in the brainstem. These nerves control the motor and sensory functions of the head, face and most of the neck. Since these nerves and nuclei are so closely located in and around the brainstem, problems in this area rarely affect only one cranial nerve. Lastly, management of the essential involuntary functions of heart rate, blood pressure and respiratory rate occurs in the reticular networks of the brainstem, with input from the hypothalamus ***(Gupta and Summors, 2001)***

The brain stem is formed of:

a- The cerebral peduncles (midbrain)

These are two cylindrical masses situated at the base of the brain, and largely hidden by the temporal lobes of the cerebrum. They emerge from the upper surface of the pons, one on either side of the middle line, and, diverging as they pass upward and forward, disappear into the substance of the cerebral hemispheres ***(Martin, 2000).***

b- The Pons

It is situated in front of the cerebellum. Behind and below the pons is continuous with the medulla oblongata, but is

separated from it in front by a furrow in which the abducent, facial, and acoustic nerves appear ***(Martin, 2000).***

c- The Medulla Oblongata

It extends from the lower margin of the pons to a plane corresponds with the upper border of the atlas behind, and the middle of the odontoid process of the axis in front; at this level the medulla oblongata is continuous with the spinal cord. It is pyramidal in shape. The central canal of the spinal cord is prolonged into its lower half, and then opens into 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 portion of the fourth ventricle ***(Martin, 2000).***

3- The cerebellum

The cerebellum functions primarily in the regulation of fine motor control and the coordination of movements necessary in equilibration, locomotion and apprehension (***John et al., 2008).***

It lies directly under the posterior temporal and occipital lobes in the posterior fossa of the cranium. It is separated from the cerebral cortex by the tentorium. It lies behind the pons and medulla oblongata; between its central portion and these

structures is the cavity of the fourth ventricle. Its average weight in adults is about 150 gms. In the adult the proportion between the cerebellum and cerebrum is about 1 to 8, in the infant about 1 to 20. It consists of three parts, a median (vermis) and two lateral hemispheres, which are continuous with each other. The cerebellum is connected to the cerebrum by the superior peduncle, to the pons by the middle peduncle, and to the medulla oblongata by the inferior peduncles (***Mendoza and Foundas, 2008).***

Deep Structures of the Brain

Sitting atop the brainstem are the deep brain structures of the hypothalamus, thalamus and basal ganglia. These are primarily relay and control stations for endocrine and the autonomic nervous systems and receive enormous amounts of sensory input ***(Gupt and Summors, 2001)***

The Meninges of the Brain (figure-2)

The brain and spinal cord are enclosed within three membranes. These are named from without inward: the dura mater, the arachnoid, and the pia mater ***(John et al., 2008).***

The Dura Mater

The dura mater is a tough, fibrous membrane that adheres firmly to the internal surface of the skull**.** At specific sites the dura splits into two leaves that enclose the large venous sinuses that provide the major venous drainage from the brain.

Laceration of theses venous sinuses may result in massive hemorrhage. It sends inward four processes (the falx cerebri, the tentorium cerebelli, the falx cerebelli, and the diaphragma sellae) which divide the cavity of the skull into a series of freely communicating compartments ***(John et al., 2008).***

The arachnoid mater

Beneath the dura is a second meningeal layer, the thin transparent arachinoid membrane. Because the dura is not attached to the underlying arachnoid, the arachnoid is separated from the pia mater by wide intervals, which communicate freely with each other and are named subarachnoid cisternae; in which the subarachnoid tissue is less abundant. a potential space between these layers exists (the subdural space), Into which hemorrhage may occurs. In brain injury, bridging veins that travel from the surface of the brain to the venous sinuses within the dura may tear, leading to the formation of subdural hematoma ***(John et al., 2008).***

The pia mater

It is a vascular membrane, consisting of a minute plexus of blood vessels, held together by an extremely fine areolar tissue and covered by a reflexion of the mesothelial cells from the arachnoid trabeculae, It is the third layer and is firmly attached to the surface of the brain. Cerebrospinal fluid (CSF) fills the space between the watertight arachnoid and the pia

matter (the subarachnoid), cushioning the brain and spinal cord. Hemorrhage into this fluid-filled space (subarachnoid hemorrhage) is frequently seen in the brain contusion or injury to major blood vessels at the base of the brain ***(John et al, 2008).***

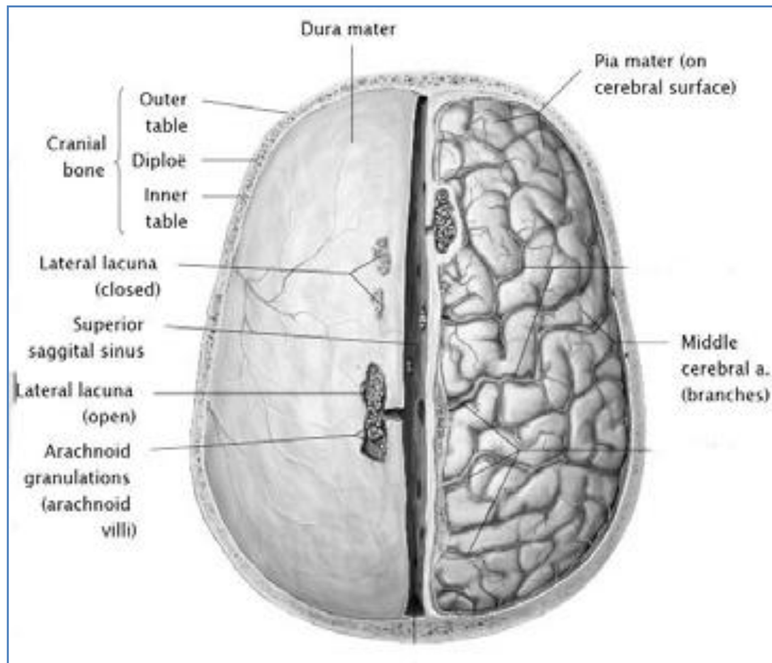

Fig. (2): Meninges of the brain ***(Mendo and Foundas, 2008).***

2-The Blood Supply of the Brain

A- Arterial supply of the brain (figure-3)

The arterial supply to the brain is from both right and left internal carotid arteries (ICAs) supplying the anterior two-thirds of the cerebral hemispheres and the vertebrobasilar system, which supplies the brainstem and the posterior regions of the hemispheres. The ICA enters the skull through the foramen

lacerum and turns anteriorly through the cavernous sinus in the carotid groove on the side of the sphenoid body. Each ICA gives rise to a posterior communicating artery before ending by dividing into the anterior cerebral artery (ACA) and middle cerebral artery (MCA). The ACA runs medially then superiorly, supplying the undersurface of the frontal lobe and the medial neostriatum. The MCA turns laterally from its origin, immediately giving rise to a series of small penetrating branches. These arteries are the only supply to the lateral part of the striatum. The MCA continues to run laterally where it divides into several major branches carrying blood to the lateral surfaces of the frontal, temporal and parietal lobes (***Duvernoy et al., 2000).***

The vertebral arteries arise from the subclavian arteries at the base of the neck. They fuse to form the basilar artery at the level of the pontomedullary junction. The basilar artery lies on the ventral surface of the brainstem and supplies blood to the Pons, midbrain and cerebellum. At the level of the midbrain the artery bifurcates to form two large posterior cerebral arteries (PCAs), from which several small branches arise (***Duvernoy et al., 2000).***

The anastomoses between the internal carotid system and the vertebrobasilar systems form the Circle of Willis. It is located in the interpenduncular cistern and encloses the optic

chiasma, pituitary stalk and mamillary bodies. The 'classic' polygonal anastomotic ring is found in less than 50% of brains. From its anterior part proceed the two anterior cerebrals, from its antero-lateral parts the middle cerebrals, and from its posterior part the posterior cerebrals (***Duvernoy et al., 2000).***

Principal arteries give origin to two different systems of secondary vessels. One of these is named the ganglionic system and the other is the cortical system. These two systems don't communicate at any point of their peripheral distribution and are independent of each other. These arteries are, ICA(internal carotid artery), ACA(anterior cerebral artery), MCA(middle cerebral artery), PCA(posterior cerebral artery), ACoA(anterior communicating artery), PcoA (posterior communicating artery), SCA (superior cerebellar artery (***Duvernoy et al., 2000).***

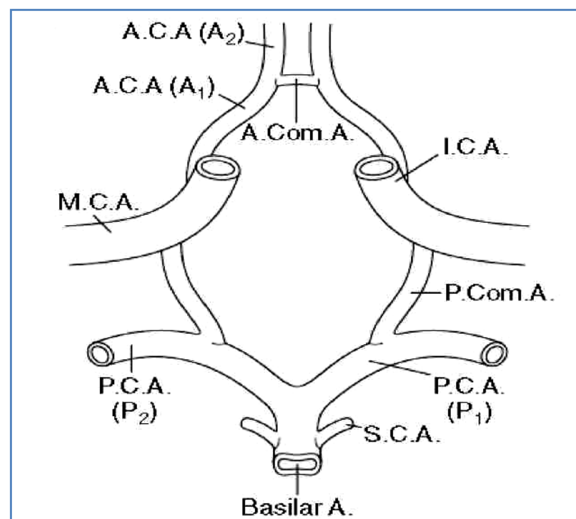

Fig. (3): Anatomy of the Circle of Willis ***(Burnstein, 2001).***

B-Venous drainage of the brain (figure-4)

It comprises a series of external and internal veins, which drain into the venous sinuses. The veins of the brain possess no valves, and their walls, owing to the absence of muscular tissue, are extremely thin. They pierce the arachnoid membrane and the inner or meningeal layer of the dura mater, and open into the cranial venous sinuses. They may be divided into two sets, cerebral and cerebellar (***Harold, 2006).***

The cerebral veins are divided into external and internal groups. The external veins are the superior, inferior, and middle cerebral. They drain the outer surfaces of the brain. The inner parts of the hemispheres are drained by the deep cerebral veins.

The cerebellar veins are placed on the surface of the cerebellum and are disposed in two sets, superior and inferior ***(Harold, 2006).***

The venous sinuses are endothelialised channels, continuous with the endothelial surface of the veins, which lie between folds of dura mater. They have no valves and their walls are devoid of muscular tissue.

They may be divided into two groups:

(1) A postero-superior, at the upper and back part of the skull. It comprises the superior sagittal, inferior sagittal and occipital.

(2) An antero-inferior, at the base of the skull. It comprises the two cavernous, two intercavernous and the basilar plexus. The sinuses drain into the internal jugular vein (IJV), which are continuous with the sigmoid sinus at the jugular foramen. The IJV has a 'bulb' at its upper end, which is an enlargement in the wall of the vein. At the level of the jugular bulb the IJVs receive minimal venous return from extra cranial tissue and measurement of oxygen saturation at this level can be used as a measure of cerebral oxygenation (***Harold, 2006)***

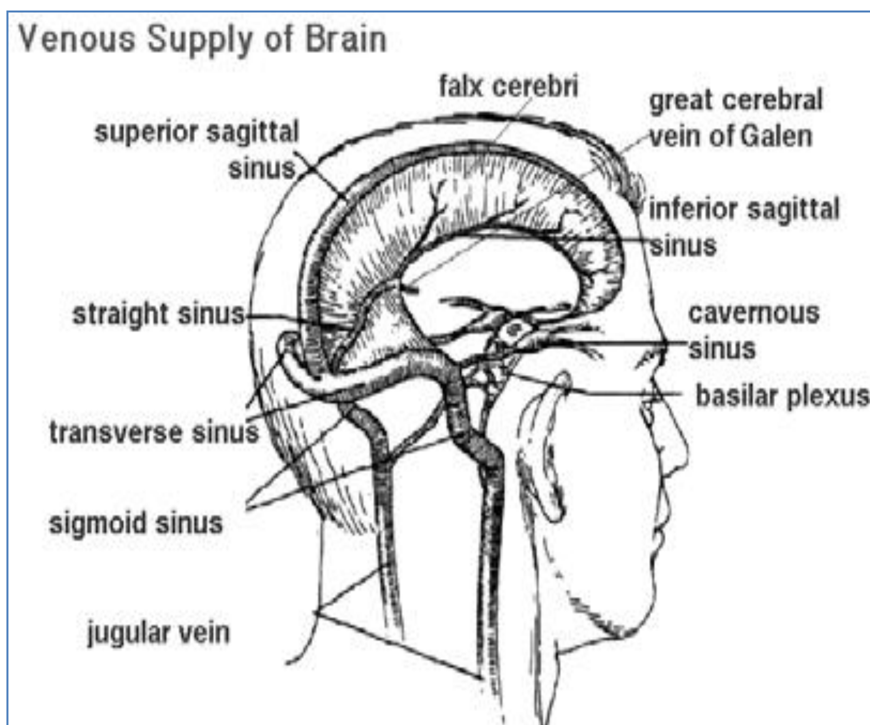

Fig. (4): Venous drainage of the brain (***Harold, 2006)***