THE VALUE OF COMPUTERIZED AXIAL TOMOGRAPHY IN MANAGEMENT OF CONGENITAL HYDROCEPHALUS

THESIS

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TO MY BELOVED PARENTS

بسم الله الرحمن الرحيم

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Aim Of The Work

CAT scan was first introduced in Egypt by late professor Talat Abdel Hamid in 1978. Since then it has become one of the essential investigations for patients with intracranial disorders.

The aim of this work is to study the impact of the compterized tomography in the management of congenital hydrocephalus as a common neuropediatric disorder. Better understanding of the pathophysiolog-ical aspects of the disease is expected and, accordingly, more precise approaches to the management would be possible.

REVIEW OF LITERATURE

Historical Aspects.

Definition.

Anatomy Of The Cerebrospinal Fluid Compartments.

Physiology Of The Cerebrospinal Fluid.

Pathology Of Congenital Hydrocephalus.

Diagnosis Of Congenital Hydrocephalus.

Management Of Congenital Hydrocephalus.

Over View Of CT Scanning.

CT Findings In Cases Of Suspected Congenital Hydrocephal

C O N T E N T S

INTRODUCTION

The discipline of pediatric neurosurgery has evolved rapidly in recent years. Accomplishment in the neurosciences,coupled with advances in surgical technique and supportive management,have made the solution of complex problems affecting the developing nervous system. In the 1970s a revolutionary development of new approaches tothe diagnosis and treatment of many neuropediatric disorders has occurred. So numerous have been these advances,and so extraordinary has been the impact of computerized axial tomography in the diagnosis and follow-up of children with neurosurgical problems,that certain aspects of the specialty bear little resemblance to those at the beginning of this decade.

The task of recognizing disorders of neurosurgical importance usually falls to the pediatrician. Thereafter, the neurosurgeon,in conjunction with the pediatric neurologist, is called upon to formulate an appropriate plan of diagnostic evaluation and to conduct the necessary surgical procedure. This task has been greatly facilitated by the use of the computerized axial tomography.

HISTORICAL ASPECTS

The large head,ascribed to " water on the brain " has long attracted attention and speculation. In reality, Hippocrates referred to hydrocephalus on two occasions. Both situations were relevant to external rather than internal hydrocephalus. Galen(130-200AD) wrote about hydrocephalus, and also described fluid that had accumulated external to the brain(Richard M. Torack,1982). Could it be possible that internal hydrocephalus was missed by both the Greeks and the Romans ?!

The description of ventricular dilation by Vesalius about 1550AD is widely accepted as the first modern recognition of internal hydrocephalus. The subsequent history of hydrocephalus has been documented by Morgagni(1682-1771). He discussed past uncertainities of the source of the fluid and confirmed its origin to be in the ventricles. He also recognized that hydrocephalus could occur in the adult without enlargement of the head. In the 19th century,the understanding of the anatomy of the cerebrospinal fluid pathways had advanced by the works of Magendie,Luschka,Key and Retzius,and Monro. Weed's embryological researches(1917), demonstrating the development of the choroid plexuses and the openings of the subarachnoid spaces,influenced a host of observations of the production and circulation of cerebrospinal fluid that has extended to the present day.

The classic " Observations on the Pathology of Hydrocephalus " by Dorothy Russell(1949) provided an impressive collection of various pathological lesions producing hydrocephalus,all of which were believed to create obstruction at some point in the pathway of the cerebrospinal fluid.

Up to the beginning of this century the pathological background of cases with enlarged head was searched for clinically,during surgical procedures,and more commonlly after death.

The discovery of the X-ray beam by Roentgen in 1895 was rapidly followed by its diagnostic application to the nervous system. More advances were achieved by the introduction of air ventriculography(Dandy,1918),and air encephalography(Dandy,1919). In 1927, Egas Moniz published a report of his first attempts at cerebral angiography in human patients(Moniz,1927).

The ingenious discovery of the computerized axial tomography by the British engineer Godfrey Hounsfield in 1973, is regarded as the greatest step in radiology since the discovery of X-rays by Roentgen in 1895. It resulted in the Nobel prize for medicine being awarded jointly to Dr.Hounsfield and Prof.A.M.Cormack.

The plan of treatment of hydrocephalus has developed hand in hand with the contineous correction of our knowledge about the pathology of the disease. More understanding of the disorder allowed better management of patients and subsequently better prognosis.

The surgical approach was recommended by Claudius Galen(130-200AD) to release the accumulated fluid from the skull. This surgical approach appeared again,as seen in his letter to Wepfer during the early 18th century, when Fantoni punctured the patient on the side of his head.

In the " Handbuch der speziellen Pathologie und Therapie " Rudolf Virchow(1869) referred to the method used by Bernhard von Langenbech(1810-1887) to puncture the anterior horn of the lateral ventricle to treat hydrocephalus. This was done by introducing a trocar behind the upper eyelid and piercing the top of the orbital cavity(Bergmann von, E,1888).

Because these ventricular punctures almost always proved fatal,it is not surprising that medical management was more common,especially since " cures " were reported (Eason,1795). A more direct approach was discovered by Riverius in 1656,when he used muslin bandages to compress the enlarging cranium. In 1838,Barnard substituted plaster for the muslin(Barnard J F,1838). The cures that occurred following various medical regimens seem to represent the earliest examples of " spontaneous arrest ".

The redefinition of the correct cerebrospinal fluid physiology by Key and Retzius in 1876,had a profound effect on the management of hydrocephalus. In 1879, Hilton expressed the first modern description of obstructive hydrocephalus. The founders of neurosurgery: Keen,Roswell,Miculicz,and especially Harvey Cushing belong to the new era in which any mechanical block of the cerebrospinal fluid flow necessitated surgical intervention. Most of these procedures involved some indwelling tubes,which would divert the excess fluid from the ventricles.

Dandy's experiments confirmed the lateral ventricular origin of cerebrospinal fluid. Its secretion by the choroid plexus was not only universally accepted but also visually confirmed by Cushing during a ventriclotomy to remove a papilloma(Cushing H,1914).

DEFINITION

Russell(1949) quoted a passage from Vesalius from which it was clear that the feature which had attracted the attention of the ancients had been the enlarged head and they had called this disease hydrocephalus due to the water stored in the head and gradually collecting to manifest itself in favourable circumstances(in a child)by an expansion of the head.(Russell,D.S.,1949)

The Shorter Oxford English Dictionary(1950) defines this Greek word as " an accumulation of serous fluid in the cavity of the cranium resulting in gradual expansion of the skull...."

The term hydrocephalus, although technically including an accumulation of fluid any where within the cranium,commonly implies only the progressive dilation of the ventricular system.

In the light of the current knowledge,we should define hydrocephalus as " an excessive accumulation of cerebrospinal fluid within the cerebral ventricles due to a disturbance of its secretion,its flow,or its absorption(Milhorat,T.H. ,1973).

Hydrocephalus in this sense must be carefully distinguished from cerebral atrophy in which,an excessive accumulation of cerebrospinal fluid within the intracranial cavities is due to a loss of cerebral substance rather than a primary defect of cerebrospinal fluid formation or absorption. In cerebral atrophy the accumulation of fluid is a compensatory mechanism for the shrinkage of the brain tissue. This may be termed " hydrocephalus ex vacuo ".

ANATOMY OF CEREBROSPINAL FLUID COMPARTMENTS

The central nervous system is hollow; it develops from a neural tube whose cavity persists. The cavity is lined throughout with ependyma. The ependyma originates from the neuroectodermal cells of the primitive neural tube. A few ependymal derivatives are subsequently modified to form the choroid plexuses,paraphysis,pineal body,neurohypophysis,and the subcommissural organ (Lemire,et al,1975). A relatively inactive layer of these cells persists,covering the choroid plexus and lining the cavities of the brain and spinal cord.

The lining ependyma comes into contact with the surface pia matter,with no grey or white matter between,to allow the choroid plexuses to invaginate. That is to say;the ventricular cavity comes to the surface without opening thereon (G.J.Romanes,1971).

Each cerebral hemisphere possesses its cavity;the lateral ventricle,and this comes to the surface at a C-shaped slit at the medial surface of the hemisphere ,called the choroid fissure. The choroid plexus of the lateral ventricle is invaginated here.

The C-shaped cavity of the lateral ventricle consists of named parts. On the upward convexity is the body, roofed by the corpus callosum. The body projects forwards into an extremity,the anterior horn. Its backward projection is the posterior horn towards the occipital pole. It is most variably developed(Davies,A.V.,Coupland,R.E.,1972). The inferior horn projects downwards and forwards in the temporal lobe.

The diencephalon has a slit-like space,the third ventricle. It lies in the sagittal plane and much of its lateral wall is occupied by the thalamus. It comes to the surface on its roof,and here are invaginated the two choroid plexuses of the third ventricle.

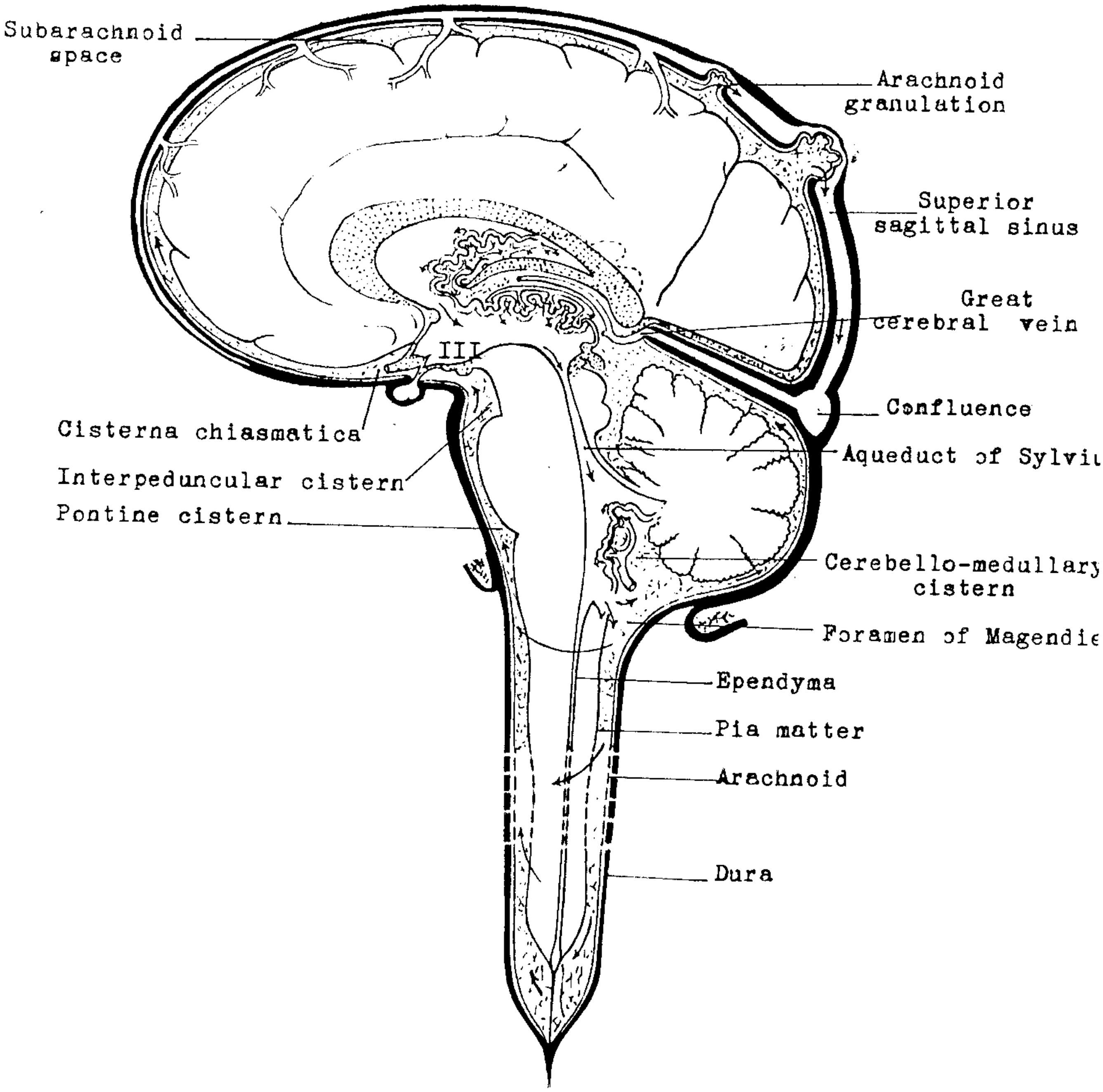
The pons and medulla share a cavity which reaches the surface at the upper medulla,where the roof is invaginated by the right and left choroid plexuses of the fourth ventricle. The roof of the fourth ventricle is updrawn into a tent shape and is covered by the cerebellum.

The choroid plexuses of the lateral ventricles are large and highly vascular. This pair secretes the main bulk of the cerebrospinal fluid. The choroid plexuses of the third and fourth ventricles are minute and they secrete only a small percentage of the total cerebrospinal fluid output.

Each lateral ventricle opens into the third ventricle by the interventricular foramen of Monro. From the third ventricle the aqueduct opens below into the fourth ventricle. Below the fourth ventricle the central canal extends as a tiny tube through the spinal cord. (see the figure)

The only apertures in this system lie in the roof of the fourth ventricle;a median aperture of Magendie and two lateral apertures of Luschka.

The interior of the cranium is lined with the dura matter,and the surface of the brain is covered with the pia matter. Between the two, in contact with the dura matter, lies an impermeable delicate membrane known as the arachnoid



Cerebrospinal Fluid Compartements(Diagramatic)