ROLE OF MAGNETIC RESONANCE IMAGING IN PEDIATRIC BRAIN TUMORS

THESIS

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بسم الله الرحمن الرحيم

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TO MY PARENTS

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INTRODUCTION

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Because of its unique features;of exceptionally high soft tissue contrast and ability to image in any pre determined orientation;**MRI** has been considered a major step foreward in medical imaging.

The number and complexity of MR studies performed in children has increased markedly over the last decade.

The aim of this work is to throw some light on the value of magnetic resonance (MR) in the evaluation of pediatric brain tumors.

ANATOMY

NORMAL ANATOMY AND DEVELOPMENT OF THE NEONATAL AND INFANT BRAIN:

Embryology :

The bilateral cerebral vesicles that will form the cerebral hemispheres first appear at 35 days of gestation as out-pouchings of the telencephalon from the region of the formina of Monro.At this time,the walls of the vesicles are uniformaly thin and are connected in the midline by the lamina terminalis.The lamina terminalis does not grow; however,the cerebral vesicles exhibit marked expansion laterally,rostrally,ventrally, and caudally. As the vesicles expand, cellular layers develop within their walls,forming the germinal matrices from which the cellular components for the cerebral hemispheres and the basal ganglia will eventually develop.Vascular areas develop on the dorsal medial aspect of each vesicle,marking the primordia of the choroid plexuses of the lateral ventricles. ***[McArdle, et al., 1987].***

During the early weeks of gestation,the surfaces of the cerebral hemispheres are smooth [lissencephaly].The fetal sulci appear in an orderly sequence;the phylogenetically older sulci appear first,and the more recently acquired sulci appear later.The principal sulci and gyri form the characteristic pattern of the human cortex that can be identified in the full-term infant.The primitive Sylvian fissure,the earliest fetal sulcus,first appears during the fifth gestational month.This is followed by the rolandic [central], interparietal,and superior temporal sulci, which appear toward the end of the sixth and begninning of the seventh gestational months. ***[McLeod,etal.,1987].***

Myelination of the brain begins during the fifth fetal month with the myelination of the cranial nerves and continues throughout life In general,the myelination progresses from caudal to cephalad,and from dorsal to ventral.The brain stem, therefore,myelinates prior to the cerebellum and basal ganglia.Similarly,the cerebellum and bsasl ganglia myelinate prior to the cerebral hemispheres, Within any particular portion of the brain,the dorsal apect tends to myelinate first.Therefore,the dorsal brain stem, containing the medial lemniscus and medial longitudinal fasciculus, tends to myelinate prior to the ventral brain stem,which contains the cortico-spinal tracts.Similarly,the occipital lobes of the cerebral hemispheres myelinate first, whereas the frontal lobes [the most ventral and most rostral portion] myelinate last ***[Bird,et al.,1987].***

Another general trend in the maturation of the brain is that myelination of fiber systems mediating sensory input to the thalamus and the cerebral cortex precedes myelination of those fiber systems that correlate the sensory data into movement.Thereofre,in the brain stem the medial longitudinal fasciculus,lateral and medial leminisci,and inferior and superior cerebellar peduncles,which transmit vestibular, acoustic,tactile,and proprioceptive sense, are myelinated at birth, whereas the middle cerebellar peduncles, which integrate cerebral activities into the cerebellum,acquire myelin later and more slowly. Similarly,in the cerebrum, the geniculate and calcarine [optic], postcentral [somesthetic], and precentral [proprickinesthetic] regions acquire myelin early, whereas the posterior parietal and frontal areas, which integrate the sensory experience,acquire myelin later *[Lemire,et al.,1975]*.

Myelination proceeds rapidly within the brain up to 2 years of age.The process slows markedly after 2 years, although fibers to the association of areas of the brain continue to myelinate well into the third and fourth decades of life. *[Bird,et al.,1987]*.

***MR Of Brain Development*:**

Brain maturation occurs at different rates and at different times on the T1 - weighted images than on the T2-weigted image. On short TR/TE images, the appearance of the newborn brain is similar to that of long TR/TE images in

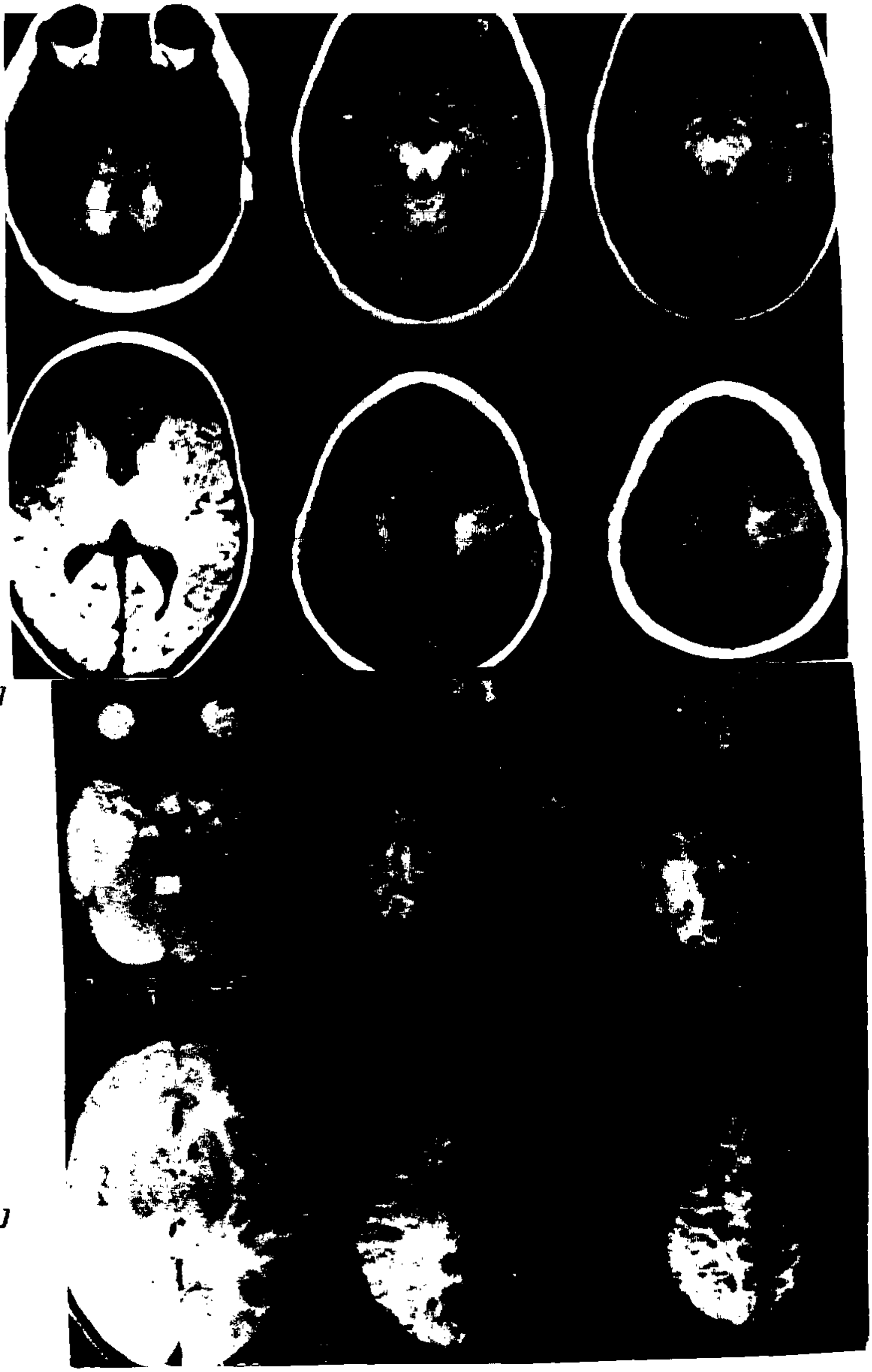
[A]

[Fig. 1] MR of the brain of a normal 2-week old infant.
A. Axial T_1- weighted images.
B. Axial T_2- weighted images.
Quoted from: Pediatric Neuroimaging Textbook,
A.James Barkovich, M.D., 1990.

adults: white matter is lower signal intensity than grey matter. With maturation, the intensity of white matter increases relative to gray matter.

Neonatal posteior fossa structures that exhibit high signal intensity at birth include the medulla,the dorsal midbrain,and the inferior and superior cerebellar peduncles. [Fig. 1]. An increase in signal intensity of the deep cerebellar white matter appears near the end of the first month of life steadily increases, with arborization into the cerebellar folia appearing by the third month. At 3 months of age, the cerebellum has an appearance similar to that seen in the adult on both axial and sagittal images. Signal intensity in the basis pontis increases less rapidly,occurring during the third through the sixth months. *[Dietrich et al., 1988]*.

In the supratentorial region,the decussation of the superior cerebellar peduncles,the ventral lateral region of the thalamus,and the posterior limb of the internal capsul exhibit high signal intensity at birth. [Fig. 1]. The development of high signal intensity proceeds rostrally from the pons along the cortico-spinal tracts into the cerebral peduncles, posterior limb of the internal capsule,and the central portion of the centrum semiovale.The white matter of the pre-and postcentral gyri are of high signal intensity by 1 month of age.The change to high signal intensity in the



[A]

[B]

[Fig. 2] MR of the brain of a normal 4 month old infant.

A. Axial T_1- weighted images.

B. Axial T_2- weighted images.

Quoted from: Pediatric Neuroimaging Textbook,
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motor tracts is essentially complete by 3 months of age. In infants younger than 1 month of age, high signal intensity is present in the optic nerve, optic tracts, and optic radiations; by 3 months of age, the occipital white matter surroinding the calcarine fissure is of high signal intensity. The posterior limb of the internal capsule is of high signal intensity at birth; high signal intensity does not develop in the anterior limb until 2 to 3 months of age. The splenium of the corpus callosum shows high signal intensity in all infants by 4 months. [Fig. 2]. The increase in signal intensity proceeds rostrally; the genus is always of high signal intensity by 6 months of age. Typically, at 4 to 5 months of age, the splenium is high is signal intensity, whereas the genu is low in signal intensity. Maturation of the subcortical white matter other than the visural and motor regions begins at 3 months. The deep white matter matures in a dorsal to rostal direction, with the deep occipital white matter maturing first and the frontal white matter last. Peripheral extension and increasing complexity of arborization of the subcoritcal white matter continue until 7 months of age in the occipital white matter and 8 to 11 months in the frontal white matter. Only minimal changes are seen on the T1-weighted images after 8 months, consisting of increasing signal intensity in the most peripheral regions of the white matter. *[Barkovich, et al., 1988]*. [Fig. 3].