The Role of Phase Contrast MRIin Studying Cerebrospinal Fluid Dynamics in Relevant Pathologies

Essay

Submitted for the Partial Fulfilment of

Master Degree of Radiodiagnosis

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2013

Acknowledgement

First of all, I thank Allah for all his blessings and care, that helped me finish this work.

I would like to express my thanks and deep gratitude to ***Prof. Dr. Mounir Sobhy Guirguis*** *Professor of Radiodiagnosis, Faculty of Medicine, Ain Shams University, for his guidance, advice and thoughtful remarks.*

Also I would like to express my thanks and appreciation to ***Dr. Rania Mohammed Refaat Abd El Hamid*** *Lecturer of Radiodiagnosis, Faculty of Medicine, Ain Shams University, for his continuous encouragement, help and valuable comments.*

Last but not least, I would like to thank my family for their help and encouragement and I would like to dedicate this work to them.

List of Contents

Title	Page No.

List of Tables

Table No.	Title	Page No.

List of Figures

Fig. No.	Title	Page No.

List of Figures *(Cont...)*

Fig. No.	Title	Page No.

List of Figures *(Cont...)*

Fig. No.	Title	Page No.

List of Figures *(Cont...)*

Fig. No.	Title	Page No.

List of Figures *(Cont...)*

Fig. No.	Title	Page No.

List of Abbreviations

Abb.	Full term
AC	*Arachnoid cysts*
ACSV	*Aqueductal CSF stroke volume*
AS	*Aqueductal stenosis*
BPC	*Persistent Blake's pouch*
CECT	*Contrast enhanced computed tomography*
CTC	*Computed tomography cisternography*
CIM	*Type I Chiari malformation*
CIIM	*Type II Chiari malformation*
CSF	*Cerebrospinal fluid*
CT	*Computed tomography*
DWM	*Dandy-Walker malformation*
DMV	*Dandy-Walker variant*
ECG	*Electrocardiography*
ETV	*Endoscopic third ventriculostomy*
FLAIR	*Fluid attenuation inversion recovery*
FLASH	*Fast low angle shot*
Gd	*Gadolinium*
GRE	*Gradient recalled echo*
HR	*Heart rate*
ICP	*Intracranial pressure*
MCM	*Mega cisterna magna*
MRI	*Magnetic resonance imaging*
NECT	*Non enhanced computed tomography*
NEX	*Number of excitations*
NPH	*Normal pressure hydrocephalus*
PC-MRI	*Phase contrastmagnetic resonance imaging*
PD	*Proton density*

PSV Peak systolic velocity
PDV Peak diastolic velocity
R-D Time after R wave to onset of CSF diastole.
ROI Region of interest
R-PDV R-wave to peak diastolic velocity.
R-PS Time after R wave to peak of CSF systole
R-S Time after R wave to onset of CSF systole
SDFC Subdural fluid collection
SNR Signal to noise ratio
SV Stroke volume
TE Echo time
TR Repetition time
Venc Velocity encoding
VP shunt Ventriculoperitoneal shunt
2 D 2 dimensions
3D 3dimensions

INTRODUCTION

The Cerebrospinal Fluid (CSF) flow is influenced by twoseparate processes; the circulationof the CSF from its formation sites to its absorption sites (i.e., bulk flow) and an oscillatory (back and forth) flow during the cardiac cycle (pulsatile flow) ***(Alperin et al., 2006).*** Phase contrast MRI non invasively displays this pulsatory CSF motion and allows assessment of its amplitude ***(Bhadelia et al., 1997).***

Cine phase contrast MRI has many advantages other than non invasivenessincluding no need for patient preparation or contrast media injection, no ionizing radiation exposure and overall examination duration less than 15 min***(Unal et al., 2009).***Moreover, it is extremely sensitive, even to slow flow ***(Schroeder et al., 2000).***

Phase contrast MR flow studies can be used as a selective noninvasive method for establishing the diagnosis of normal pressure hydrocephalus ***(Al-Zain et al., 2008),***to discriminate between communicating hydrocephalus andnon communicating hydrocephalus, to localize the level of obstruction in obstructive hydrocephalus, to differentiate between arachnoid cysts and subarachnoid space enlargement and to determine whether arachnoid cysts communicate with the subarachnoid space ***(Yildiz et al., 2006).***

Cine phase-contrast MR imaging for CSF flow evaluation may be a useful adjunct to routine MR imaging in the evaluation of the cystic malformations of the posterior fossa because it can improve the specificity in differentiating such malformations ***(Yildiz et al., 2006).*** Phase contrast cine MR imagingis considered a reliable method for evaluating the patency of a third ventriculostomy ***(Fukuhara et al., 1999)*** and has been adopted for the assessment of CSF flow in a variety of disorders including Chiari I malformation and syringomyelia ***(Wentland et al., 2010).***

AIM OF THE WORK

Aim of this work is to emphasize the role of phase contrast MRI in evaluation of CSF flow in relevantpathologies.

ANATOMICAL AND PHYSIOLOGICAL BASIS FOR CSF PATHWAY

A- The anatomy of ventricular system:

The cerebral ventricular system consists of a series of interconnecting spaces and channels within the brain *(Figure 1)* which are derived from the central lumen of the embryonic neural tube and the cerebral vesicles to which it gives rise:

- Two lateral ventricles.
- Third ventricle.
- Fourth ventricle ***(Crossman, 2005).***

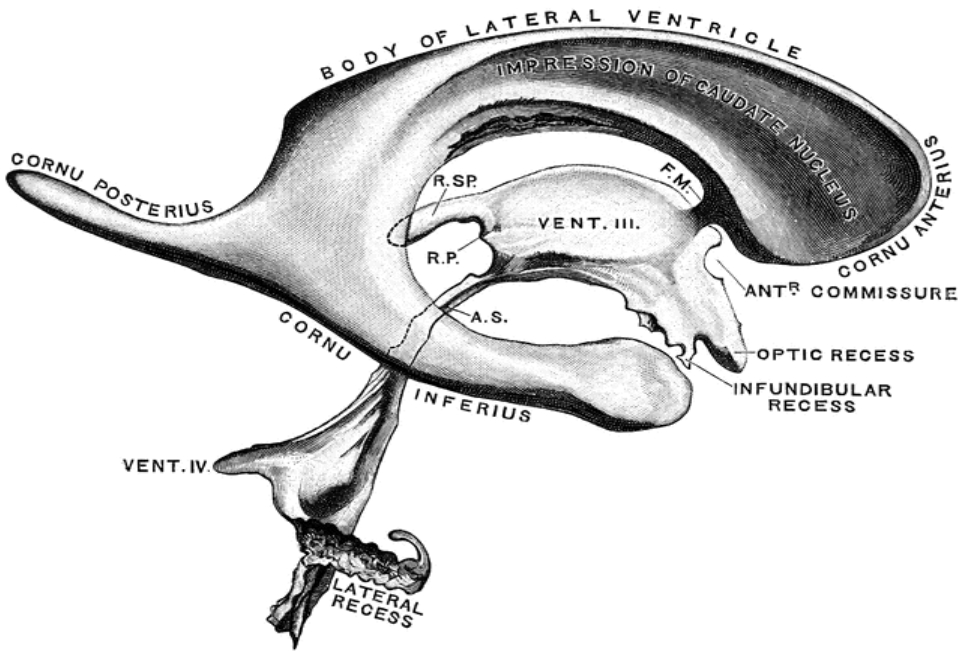

Figure (1): ventricles of the brain. Labels" R.SP. recessus suprapinealis; R.P., recessus pinealis inferius; A.S., aqueduct of Sylvius; F.M., foramen of Monro ***(Cunningham and Romans, 1993).***

- ***Lateral Ventricle:***

Within the cerebral hemisphere lies the lateral ventricle. Viewed from the lateral aspect, the lateral ventricle has a roughly C-shaped profile (*Figure 1*) with an occipital tail. It is divided into a body and frontal (anterior), occipital (posterior) and temporal (inferior) horns.

Frontal (anterior) horns

Passes forward and lateralward from the interventricular foramen into the frontal lobe. Its floor is formed by the upper surface of the corpus callosum**.** It is bounded medially by the

anterior portion of the septum pellucidum and laterally by the head of the caudate nucleus. Its apex reaches the posterior surface of the genu of the corpus callosum *(figure 2)* ***(Ryan andNicholas, 2004).***

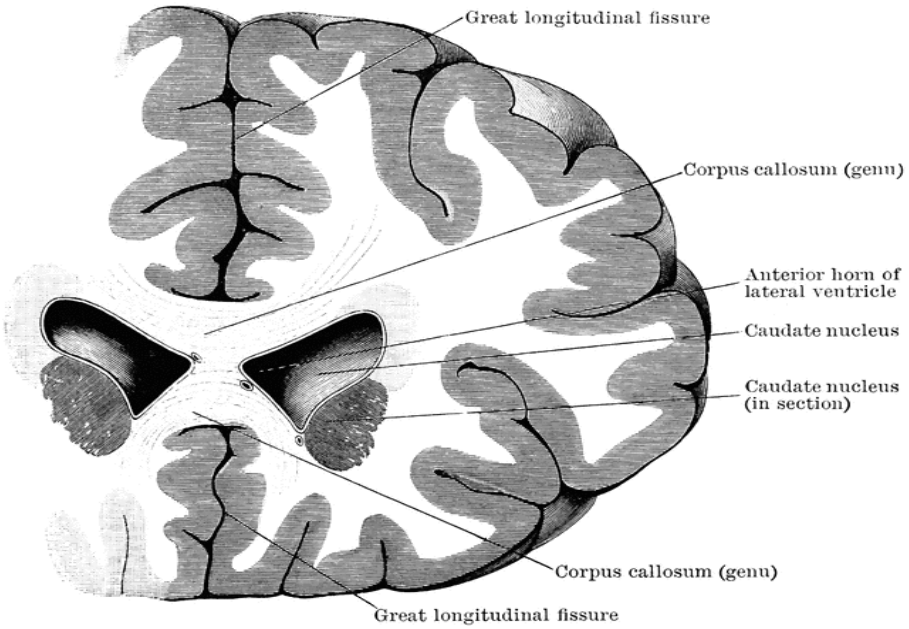

Figure (2): Coronal section through the frontal lobes and the anterior horns of the lateral ventricles ***(Cunningham and Romans, 1993).***

The ***body of the lateral ventricle*** lies within the frontal and parietal lobes, and extends from the foramen of Monro to the splenium of corpus callosum (*Figure 1*). The bodies of the two ventricles are separated by the septum pellucidum, which contains the columns of the fornices in its lower edge (*Figure 3*). The inferior limit of the body and its medial wall are formed by the body of the fornix. The coronal profile of the body is a flattened triangle with an inward bulging lateral wall formed by