INTRODUCTION

The term hydrocephalus is derived from the Greek words 'hydro' meaning water and 'cephalus' mean head, and once was called water on the brain. Hydrocephalus is the condition caused by the accumulation of an abnormally large amount of cerebrospinal fluid in the ventricular system. Normally cerebrospinal fluid (CSF) flows continually from the interior cavities in the brain (ventricles) to the thin subarachnoid space that surrounds the brain and spinal cord. After bathing the surface of the spinal cord and the base of the brain CSF passes upwards over the convexity of the hemispheres to be absorbed into the intra-cranial venous sinuses. About 500ml of this clear fluid is produced per day which replaces the total volume of CSF about 2-3 times over 24 hours (Johnston et al, 2000). CSF has three important life-sustaining functions: It balances the amount of blood in the head, bathes and protects the brain and spinal cord and finally carries nutrients between the brain and spinal cord while removing waste.

Normal flow and absorption through the subarachnoid space is dependent on proper CSF pressure in the head (called intracranial pressure). In man, the normal pressure of CSF as measured in the recumbent position by lumbar puncture varies from 25-70mm water in infants and from 65-195mm water in adults. A build up of CSF often causes a dangerous increase in pressure. The combination of CSF build up and the subsequent increase in intracranial pressure can stress brain tissue and can cause the characteristic symptoms of hydrocephalus, though they also may occur with normal pressure (Czosnyka et al, 2004).

A great variety of factors can cause hydrocephalus. Hydrocephalus may be congenital or acquired. It may further be classified as communicating or non-communicating. Among the most important, aqueductal stenosis, Chiari
malformation and normal pressure hydrocephalus have been widely studied (Bradley et al, 1991).

Normal pressure also termed idiopathic hydrocephalus consists of the clinical triad of gait in coordination, dementia, and urinary incontinence in a patient who radiographically has dilated ventricles out of proportion to any sulcal enlargement (Wilson and Williams, 2006).

Hydrocephalus is diagnosed through clinical neurological evaluation and by using cranial imaging techniques such as ultrasonography, computed tomography (CT) and conventional magnetic resonance imaging (MRI), or pressure monitoring. Recently, magnetic resonance imaging has provided considerable information regarding CSF dynamics. Initially CSF flow was only qualitatively described as the flow void signal that is best appreciated in areas of narrowing within the ventricular system such as the aqueduct. During the last decade flow sensitive cardiac gated phase contrast MR imaging techniques have been increasingly applied to study CSF flow dynamics both qualitatively and quantitatively (Craven, 2010). A physician selects the appropriate diagnostic tool based on the patient's age, clinical presentation and the presence of known or suspected abnormalities of the brain or spinal cord (Hall et al, 2011).

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The parts of the central nervous system are often considered static structures. In fact, there is motion of the brain and spinal cord as well as considerable motion of the SCSF. CSF flow takes place in a relatively orderly fashion within the skull and
spinal canal with oscillatory motion resulting from cardiac pulsations. Cardiac systole results in a pressure wave transmitted to intracranial arteries and capillaries that cause caudal flow of CSF (CSF systole) through the ventricular system, basal cisterns and foramen magnum into the cervical subarachnoid space. Following cardiac diastole, there is reversal of flow with cephalad movement of CSF (Greitz, 2004). The phase contrast technique is extremely sensitive even to slow flow and provides the potential for noninvasive flow quantification. The results of these measurements have yielded considerable information on the physiology of the normal CSF circulation. In addition, pathological CSF flow dynamics in aqueductal stenosis, Chiari malformation and normal pressure hydrocephalus have been analyzed (Rosenbaum and Ciaverella, 2004).