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Imaging of Communicating Hydrocephalus

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Hydrocephalus basically means an increase in the volume of cerebrospinal fluid (CSF) and the ventricles. As simple as it may sound, the definition and classification of hydrocephalus have been a matter of debate over many decades. Many international neurosurgical and radiological workgroups have tried to develop a consensus and over the last 5-10 years have been able to put forth a more well-defined and standardized approach. Though, the debate and controversy surrounding this topic is expected to continue, we have tried to review the most recent and consensually accepted definition and classification. Although conventionally classified as either "obstructive and nonobstructive" or "communicating and noncommunicating," none of the classification schemes were without confusion and errors. A more precise nomenclature is to divide hydrocephalus as either "communicating": with or without obstruction of CSF absorption, or as "noncommunicating": with definite obstruction to CSF absorption. We discuss communicating hydrocephalus in the current article, and the subsequent article deals with noncommunicating hydrocephalus.
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Introduction

Hydrocephalus is a complicated neurologic condition with numerous causes and treatment approach. In basic term, it implies an increase in cerebrospinal fluid (CSF) volume and concomitant increase in ventricular size. Numerous attempts to formally define hydrocephalus were made over the last few decades, each with their own limitations. In 1994, Raimondi[1] defined hydrocephalus as "any increase in CSF within the intracranial compartment." Though being very straightforward, this definition included conditions such as ex-vacuo prominence and colpocephaly and thereby failed to get widespread acceptance. Recently, Harold Rekate[2] from Barrow Neurological Institute (Phoenix, AZ) proposed the definition of hydrocephalus as "active distension of the ventricular system of the brain resulting from inadequate passage of CSF from its point of production within the cerebral ventricles to its point of absorption into the systemic circulation." Though with its own limitations, this definition was simple and described hydrocephalus as an active process with mismatch between CSF production and absorption, which can be evaluated on imaging studies. As suggested by the author, this definition should just be the starting point for consensus building among researchers, and continuous improvement and modifications should be done.[2,3] This would be necessary for better understanding of the pathophysiology of hydrocephalus and formulating treatment guidelines.

Classification of Hydrocephalus: Past and Present

The basic mechanism and classification of hydrocephalus was first proposed by Dr Walter Dandy in the year 1913. Using animal subjects, Dr Dandy identified the choroid plexus as the source of increased CSF and suggested mechanism for bypass and shunting.[4] He injected supravital dye into the ventricles and subsequently performed a lumbar puncture (LP). He then classified hydrocephalus as either "obstructive" or "nonobstructive or communicating" depending on the absence or presence of dye on LP. His research forms the primary basis of current classification, the International Classification of Diseases (ICD-10) coding and treatment models even to date.[3,4] Many different classification schemes have been proposed since then, with none of them being without controversies and none having universal acceptance. One of the most widely accepted changes to the original classification was the identification of obstructive or nonobstructive subsets within the communicating hydrocephalus group. This nomenclature (Table 1) divides hydrocephalus as communicating (with or without obstruction

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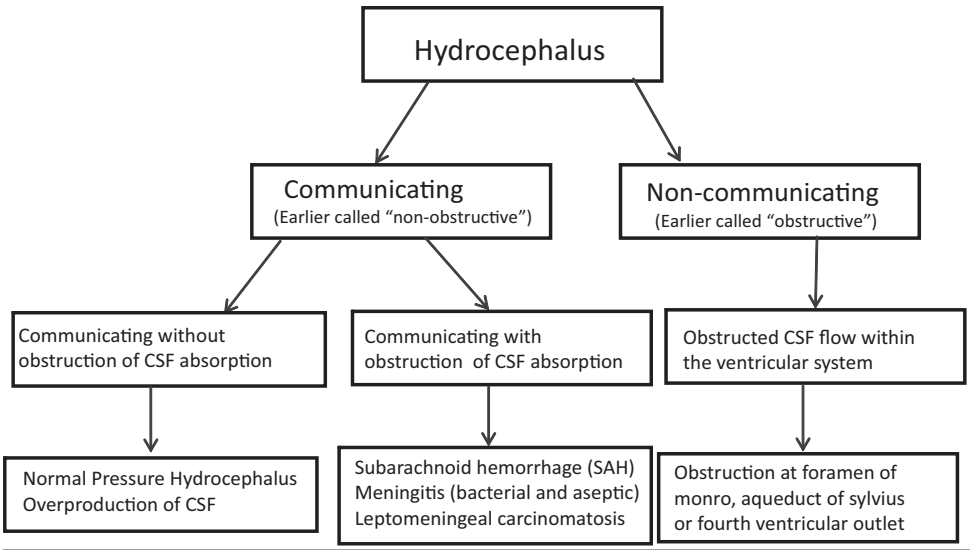
Table 1 Classification of Hydrocephalus



to CSF absorption) or noncommunicating and forms the basis for our article.[3-5] Recently, members of the International Society for Hydrocephalus and CSF Research suggested a simple "point of obstruction" model. Members of the Hydrocephalus Classification study group including Rekate[3,6] proposed a simple scheme where they suggested that all hydrocephalus is obstructive and nomenclature is based on the site of obstruction to the CSF circuit. The point of obstruction could be the foramen of Monroe, aqueduct of sylvius, fourth ventricle, basal cisterns, arachnoid granulations, or venous outflow.

Communicating Hydrocephalus

Communicating hydrocephalus occurs when there is impedance of flow of CSF after it exits the ventricles. Earlier called "nonobstructive hydrocephalus," it is now well recognized that communicating hydrocephalus can itself be with or without obstruction.[3,7] For example, basal cistern exudates in tuberculous meningitis can fill up the arachnoid granulation and obstruct the normal flow of CSF. Given the fact that there is obstruction to flow, it should be better classified as communicating with obstruction rather than nonobstructive as per the old scheme. Earlier also classified as extraparenchymal hydrocephalus, this group includes conditions in which the flow of CSF is maintained across the fourth ventricle. Most conditions belong to the subset of communicating with obstruction where normal flow of CSF is impeded at some point between the basal cisterns and arachnoid granulation.[6,7] This includes common conditions such as subarachnoid hemorrhage (SAH) and infectious meningitis and could either be congenital (in utero pathologies) or acquired. The other subset of communicating hydrocephalus without obstruction is less well defined and controversial. This includes increased CSF production (choroid plexus papilloma) and normal pressure hydrocephalus (NPH), the latter being a very complex entity with poorly understood CSF dynamics. The latest ICD-10 coding includes secondary NPH as a subset of communicating hydrocephalus with separate coding for idiopathic NPH. The latest ICD-10 codes for hydrocephalus and their definitions are outlined in Table 2 for reference (www.who.int/classifications/icd/en).

Communicating Hydrocephalus—With Obstruction of CSF Absorption

Subarachnoid Hemorrhage

SAH accounts for approximately 5% of stroke cases with the vast majority being aneurysmal (70%-85%).[8] Although, the incidence increases with age, about 50% of patients are younger than 55 years, classically presenting with worst headache of life. Vasospasm, rebleed, and hydrocephalus

Table 2 ICD-10-CM Diagnosis Codes 2016

G91	Hydrocephalus: A disorder characterized by an abnormal increase of cerebrospinal fluid in the ventricles of the brain
G91.0	Communicating hydrocephalus (applicable to secondary normal pressure hydrocephalus)
G91.1	Obstructive hydrocephalus (noncommunicating, obstructive, blockage or stenosis of aqueduct, foramen Magendie, lateral, or third ventricle)
G91.2	(Idiopathic) normal pressure hydrocephalus
G91.3	Posttraumatic hydrocephalus, unspecified (Posttraumatic wound … infection, not elsewhere classified)
G91.4	Hydrocephalus in diseases classified elsewhere (first code underlying condition, such as congenital syphilis neoplasm)
G91.8	Other hydrocephalus (specified, not elsewhere classified)
G91.9	Hydrocephalus, unspecified (acquired, external or internal, malignant, or recurrent)