Hydrocephalus in the Adult Secondary to the Rupture of Intracranial Arterial Aneurysms

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The interest paid during the last years to the hydrocephalic syndrome in the adult is reflected in the increasing number of publications dealing with this subject.\(^1\),\(^2\),\(^3\),\(^4\),\(^5\),\(^6\),\(^7\),\(^8\),\(^9\),\(^10\),\(^11\),\(^12\),\(^13\),\(^14\),\(^15\),\(^16\),\(^17\),\(^18\),\(^19\),\(^20\),\(^21\),\(^22\),\(^23\),\(^24\),\(^25\),\(^26\),\(^27\),\(^28\),\(^29\),\(^30\),\(^31\) The nomenclature is somewhat confusing, for terms such as "occult hydrocephalus," "non-pressure hydrocephalus," "normal-pressure hydrocephalus," "low-pressure hydrocephalus," "idiopathic hydrocephalus," and "nonobstructive adult hydrocephalus" have been used to refer, within some limitations, to the same clinical entity. Some new etiological aspects have been reported,\(^8\),\(^31\) and more active therapy is being carried out in most neurological centers.

This report concerns the hydrocephalic picture that may develop in the adult secondary to subarachnoid hemorrhage from the rupture of arterial intracranial aneurysms. A classical study of the reactions caused by blood when injected in the subarachnoid space and the relation of these reactions to the development of hydrocephalus was reported in 1928 by Bagley.\(^4\),\(^5\) Although since then both clinical\(^5\),\(^6\),\(^7\),\(^8\),\(^11\),\(^12\),\(^13\),\(^14\),\(^15\),\(^16\),\(^17\),\(^18\),\(^19\),\(^20\),\(^21\),\(^22\),\(^23\),\(^24\) and pathological\(^8\),\(^9\),\(^10\),\(^11\),\(^12\),\(^13\),\(^14\) reports on short series have been published, there are still no statistics on the incidence of this complication in a large series of adults\(^10\) and the frequency of hydrocephalus due to basal arachnoiditis following subarachnoid hemorrhage is not known.\(^10\) Statements like these, and the fact that during the treatment of our cases some interesting clinical, radiological, and etiological factors were found, have prompted this study.

**Material and Methods**

The serial carotid angiograms of 100 consecutive patients with proven subarachnoid hemorrhage following the rupture of arterial intracranial aneurysms have been analyzed according to the following principles. The size and shape of the lateral ventricles have been studied from the appearance of the central veins outlining these cavities,\(^7\),\(^19\),\(^24\) namely, the tributaries of the internal cerebral, including the thalamostriate. The frontal projection was used to obtain a numerical expression of the width of the lateral ventricles.\(^7\) For this purpose, measurements were made from a sagittal plane tangential to the medial border of the internal cerebral vein to the most lateral extension of the thalamostriate tributaries. These figures serve as an expression of the width of the lateral ventricle at the level of the sella media.

To minimize the factor of error, the measurements were made in a standard projection and the numerical values expressed in terms of "ventriculocranial index," thus eliminating errors of magnification. This index was obtained from the quotient:

\[
\text{ventriculocranial index} = \frac{\text{lateral ventricle width in mm}}{\text{half of the skull width in mm}}
\]

The index represents the width of the ipsilateral half of the skull measured from the sagittal plane to the inner table at the level of its maximal breadth. The changes in shape of the thalamostriate vein in the anteroposterior projection (Fig. 1) were used to check our measurements in case important index changes between two angiograms were registered. The venograms on the lateral projection\(^19\),\(^24\) were used in the same way. The accuracy of this method has been reported previously.\(^7\)

In this study, we will not refer to the pneumoencephalograms done in some of the cases, because for statistical purposes we have considered the medical indications for this study as a factor of selection *per se*. Furthermore, it is a well-known fact that for measurement purposes pneumoencephalograms have some disadvantages due mainly to unequal distribution of air between the
lateral ventricles\textsuperscript{22} and a certain degree of dilatation when the air is absorbed.\textsuperscript{22}

Changes of index greater than 0.025 (approximately 2 mm on the film) between two or more consecutive ipsilateral angiograms were considered as true changes in size of the lateral ventricles and expressed in terms of dilatation or shrinkage. When the size of the ventricle increased to reach figures greater than an index of 0.33, that case was considered as having a “hydrocephalic index.” The cerebral circulation time\textsuperscript{13} was determined only on the serial angiograms performed after the third week following the last subarachnoid bleeding, consequently eliminating the influence that vasospasm, (which is usually gone by that time,\textsuperscript{5,22}) may have upon the values obtained.

The cases having enlargement of the lateral ventricles according to this evaluation have been studied separately on a clinical basis and the findings related to the radiological features. The clinical condition of our patients was analyzed according to the usual criteria accepted by different authors dealing with hydrocephalus in the adult.\textsuperscript{1,4,11,16,17,25,31}

The combination of these signs and symptoms has resulted in the classification of our case material (patients with enlargement of the lateral ventricles) into three categories (Table 1):  

- **Group 1.** Asymptomatic patients
- **Group 2.** Patients with mild signs and symptoms (initial picture)
- **Group 3.** Patients with severe signs and symptoms (advanced picture).

Although all patients included in a specific group did not necessarily have the whole complex of symptoms, each had a combination of at least three of them.

### Results

**Ventricular Dilatation.** Of the 100 patients who had subarachnoid bleeding as a consequence of the rupture of intracranial aneurysms, 34 developed definite enlargement of the lateral ventricles (Fig. 2). Of these 34 cases, 17 had a “hydrocephalic index” (above 0.33), and 27 had index values below this level (Fig. 3). In 11 cases it was impossible for various reasons to estimate the size of the lateral ventricles. In 27 patients, only one angiographic study could be analyzed; three of these angiograms showed a hydrocephalic ventriculocranial index. Whether the enlargement of the ventricles in these cases was related to the actual disease could not be stated because of a lack of previous angiograms for comparison.

**Ventricular Shrinkage.** In none of the cases could a significant shrinking of the lateral ventricles be observed except for those patients in whom a ventriculoatrial shunt had been performed (three cases). One patient who presented a constantly increasing dilatation of the lateral ventricles during 3 years of observation (angiographic studies repeated four times at 3- to 12-month intervals), and who showed in the last study a spontaneous regression, still had a hydrocephalic ventriculocranial index.