# **Shunt dependency**

 Acute Distal Internal Carotid Artery Occlusion in Which Angiography during Mechanical Thrombectomy Revealed a Shunt between the Internal Carotid Artery and the Cavernous Sinus: A Case Report

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Intraventricular hemorrhage (IVH) is a common affliction of preterm infants and often results in posthemorrhagic hydrocephalus (PHH). These patients typically eventually require permanent CSF diversion and are presumed to be indefinitely shunt-dependent.

In a cohort of patients with clinical grade aneurysmal subarachnoid hemorrhage (aSAH) at admission, larger amounts of subarachnoid blood and large ventricular size on preoperative cerebral CT, and CSF drainage in excess of 1,500 ml during the 1st week after the ictus were significant predictors of shunt dependency. Shunt dependency did not hamper outcome <sup>1)</sup>.

Aneurysmal subarachnoid hemorrhage (SAH) has been reported to induce an intrathecal inflammatory reaction reflected by cytokine release, particularly interleukin-6 (IL-6), which correlates with early brain damage and poor outcome.

CSF IL-6 values of  $\geq$ 10,000 pg/ml in the early post-SAH period may be a useful diagnostic tool for predicting shunt dependency in patients with acute posthemorrhagic hydrocephalus. The development of shunt-dependent posthemorrhagic hydrocephalus remains a multifactorial process<sup>2</sup>.

Graeb Score or LeRoux scores improve the prediction of shunt dependency and in parts of case fatality rate (CFR) in aneurysmal SAH patients therefore confirming the relevance of the extent and distribution of intraventricular hemorrhage for the clinical course in SAH <sup>3</sup>.

A significantly higher rate of shunt dependency was observed for age older than 65 years, poor initial neurological status, and thick SAH with presence of initial intraventricular hemorrhage. By understanding these factors related to development of SDHC and results, it is expected that management of aneurysmal SAH will result in a better prognosis <sup>4)</sup>.

In a study SD after aSAH showed no correlations with three of the parameters previously identified as risk factors for shunt dependent hydrocephalus, namely, the amount of SAH, the presence of IVH, or acute hydrocephalus. Instead, a longer duration of CSF drainage correlated with SD as an

independent factor. These data suggest that a longer duration of CSF drainage may be one of the risk factors for SD after aSAH  $^{5}$ .

## **Case series**

### 2015

A total of 471 patients who were part of the Barrow Ruptured Aneurysm Trial (BRAT) from 2003 to 2007 were retrospectively reviewed. All variables including demographic data, medical history, treatment, imaging, and functional outcomes were included as part of the trial. No additional variables were retrospectively collected.

Ultimately, 147 patients (31.2%) required a ventriculoperitoneal shunt (VPS) in this series. Age, dissecting aneurysm type, ruptured vertebrobasilar aneurysm, Fisher grade, Hunt and Hess grade, admission intraventricular hemorrhage, admission intraparenchymal hemorrhage, blood in the fourth ventricle on admission, perioperative ventriculostomy, and hemicraniectomy were significant risk factors (P < .05) associated with shunt-dependent hydrocephalus on univariate analysis. On multivariate analysis, intraventricular hemorrhage and intraparenchymal hemorrhage were independent risk factors for shunt dependency (P < .05). Clipping vs coiling treatment was not statistically associated with VPS after SAH on both univariate and multivariate analyses. Patients who did not receive a VPS at discharge had higher Glasgow Outcome Scale and Barthel Index scores and were more likely to be functionally independent and to return to work 72 months after surgery (P < .05).

There is no difference in shunt dependency after SAH among patients treated by endovascular or microsurgical means. Patients in whom shunt-dependent hydrocephalus does not develop after SAH tend to have improved long-term functional outcomes <sup>6)</sup>.

Wang et al. analyzed retrospectively collected data for 89 preterm patients diagnosed with grades III and IV IVH and PHH from 1998 to 2011.

Sixty-nine out of 89 patients (77.5 %) underwent ventriculoperitoneal shunt placement, and 33 (47.8 %) required at least one shunt revision and 18 (26.1 %) required multiple revisions. The mean  $\pm$  standard deviation follow-up time for shunted patients was 5.0  $\pm$  3.3 years. The majority of early failures were due to proximal catheter malfunction, while later failures were mostly due to distal catheter problems. There was a significant difference in the number of patients requiring revisions in the first 3 years following initial VP shunt insertion compared after 3 years, with 28 revisions versus 10 (p < 0.004). In 8 out of 10 patients who underwent shunt revisions after 3 years, evidence of obstructive hydrocephalus was found on imaging either in the form of an isolated fourth ventricular cyst or aqueductal stenosis.

The results suggest that in a distinct subset of patients with PHH, obstructive hydrocephalus may develop, resulting in long-term dependence on CSF diversion. Further study on the factors associated with long-term shunt dependence and revision requirements within the PHH group is warranted <sup>7)</sup>.

#### 2014

88 consecutive patients with aneurysmal SAH requiring external ventricular drain placement and endovascular aneurysm closure were included. Functional outcome and shunt dependency were assessed 90 days after event. A matched controlled sub-analysis was carried out to investigate the effects of IVF treatment (n = 14; matching criteria: age, neuro-status and imaging). Multivariate modeling was performed to identify independent predictors for permanent shunt dependency.

In IVF-patients neurological status was significantly poorer [Hunt&Hess: IVF = 4(3-5) vs. non-IVF = 3(1-5); p = 0.035] and the extent of ventricular hemorrhage was increased [Graeb Score: IVF = 7(6-8) vs. non-IVF = 3(1-4); p  $\leq$  0.001]. Consecutive matched controlled sub-analysis revealed no significant therapeutic effect of IVF with respect to shunt dependency rate and functional outcome. Multivariate analysis revealed Graeb score [OR = 1.34(1.02-1.76); p = 0.035] and sepsis [OR = 11.23(2.28-55.27); p = 0.003] as independent predictors for shunt dependency, whereas IVF did not exert significant effects (p = 0.820).

In endovascular-treated SAH patients IVF neither reduced permanent shunt dependency nor influenced functional outcome. Despite established effects on intraventricular clot resolution IVF appears less powerful in SAH as compared to ICH. Given the reported positive effects of lumbar drainage (LD) in SAH, a prospective analysis of a combined treatment approach of IVF and subsequent lumbar drain sOeems warranted aiming to reduce permanent shunting and improve functional outcome<sup>8)</sup>.

#### 1999

Of 138 patients treated for ruptured aneurysms the development of shunt dependent hydrocephalus was evaluated regarding possible predictive factors. In 15 patients (11%) ventriculo-atrial shunt was implanted due to hydrocephalus. One predictive factor was the localisation of aneurysms as patients with hydrocephalus had PcoA aneurysms in 40% compared to 20% in the group of patients without hydrocephalus and only 7% compared to 28% MCA aneurysms. An other predictive factor was the severity of the subarachnoid haemorrhage (SAH) as 7 patients out of the 15 were graded Fisher IV on admission. Furthermore, an important predictive factor was the presence of acute hydrocephalus as 13 out of the 15 patients (87%) with shunt dependent hydrocephalus had acute hydrocephalus requiring external ventricular drainage. An other possible factor was the intraoperative opening of the lamina terminalis as in 73% of the patients with shunt dependent hydrocephalus compared to 82% in the group of patients without hydrocephalus this procedure was performed during surgery. The results suggest that shunt dependency is more likely after severe SAH especially in the presence of an acute hydrocephalus and in patients with aneurysms located in the basal cisterns. Therefore treatment of the acute hydrocephalus and possible the opening of the lamina terminalis could have a positive effect on the development of shunt dependent hydrocephalus after SAH <sup>9</sup>.

#### 1979

Five patients with shunt dependency were observed to have apparently normal ventricular size despite marked increases in ventricular pressure after shunt malfunction. Elastance (dP/dV) was determined in four of these patients by removing increments of cerebrospinal fluid and measuring the resulting pressure. These patients without ventricular enlargement and with markedly increased ventricular pressure had high elastance. This group of patients with "normal volume" hydrocephalus

had distal shunt occlusions, in contrast to previously reported patients with cephalic shunt obstructions after ventricular decompression. Initial shunting in early infancy, prolonged shunt dependency, and lack of recent shunt revision were common factors in these patients. Markedly elevated pressure with normal volume is a threatening clinical entity, requiring prompt surgical intervention <sup>10</sup>.

### 1975

In suitable cases, intermittent cranial compression by means of an elastic bandage or a helmet with an inflatable inner-lining may be effective. There was arrested hydrocephalus in nine of 14 children treated with this method, eight of whom have developed normally. When cranial compression is contra-indicated or not successful, the preferred method of treatment is an 'on-off' type of valve which is used intermittently to drain a fixed volume of cerebrospinal fluid. Of 18 children who had such shunts inserted, 10 have become totally independent of their shunts and their hydrocephalus has become compensated. All are of normal intelligence. Subtemporal craniectomy was performed on seven shunt-dependent children with recurrent catheter obstruction. Four have been followed for six months and three for two years and in no case has there been further malfunction of the proximal catheter <sup>11</sup>.

# **Case reports**

Dong et al., from the Tongji Hospital, Huazhong University of Science and Technology, Wuhan, China report two children with middle cranial fossa arachnoid cysts who underwent cystoperitoneal shunt with fixed pressure valve at an opening pressure of 7 cmH2O and then developed dependency syndrome. Both patients were effectively treated by mini-invasive cyst wall excision with the shunts reserved. The clinical manifestation, radiological findings, treatment methods, and therapeutic outcomes were reviewed retrospectively.

The time from shunt surgery to shunt dependency syndrome occurrence was 4 and 2 years, respectively. Computed tomography/magnetic resonance findings of the brain showed remarkably collapsed cysts with normal or small ventricles. Both patients underwent secondary mini-invasive cyst wall excision and shunt catheters were reserved. After the operations, their symptoms were resolved except one case with marginally improved visual impairment.

Shunt dependency syndrome is a rare but dangerous complication of CP shunt and should be treated in time. Collapsed and thickened cyst wall intermittent covering the catheter head end, decreased brain compliance due to chronic fibrosis, as well as regression of cerebrospinal fluid absorption could be the pathogenesis. They suggest keyhole resection of the residual cyst wall as an effective and mini-invasive treatment option <sup>12</sup>.

Sonobe et al. report two cases of high shunt dependency, which were first thought to be shunt independent arrested hydrocephalus. Though their shunt systems didn't seem to work, symptoms of rapid increasing intracranial pressure were observed after obstruction or replacement of shunt tube. Their ventricles looked so small like a slit on CT scan and PVG that the apex of the ventricular tube were easily obstructed by a ventricle wall. This is the reason why we misjudged them to be shunt independent arrested hydrocephalus. The cause of slit-like ventricles was overflow of CSF fluid due to the low pressure valve and the siphon effect. In general, after the shunt operation, most of the cases with thickening of cerebral mantle show the shunt dependency. Especially the cases showing rapid and marked thickening of the cerebral mantle are highly shunt dependent. Therefore, we must observe such cases carefully, in which the ventricle becomes small. Short interval follow-ups by CT scan after the shunt operation are quite necessary in order to observe the ventricle size. Easy and reliable judging method to know whether the shunt system is working or not is required to be developed <sup>13</sup>.

### References

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Erixon HO, Sorteberg A, Sorteberg W, Eide PK. Predictors of shunt dependency after aneurysmal subarachnoid hemorrhage: results of a single-center clinical trial. Acta Neurochir (Wien). 2014 Nov;156(11):2059-69. doi: 10.1007/s00701-014-2200-z. Epub 2014 Aug 22. PubMed PMID: 25143185.

Wostrack M, Reeb T, Martin J, Kehl V, Shiban E, Preuss A, Ringel F, Meyer B, Ryang YM. Shunt-Dependent Hydrocephalus After Aneurysmal Subarachnoid Hemorrhage: The Role of Intrathecal Interleukin-6. Neurocrit Care. 2014 May 20. [Epub ahead of print] PubMed PMID: 24840896.

Czorlich P, Ricklefs F, Reitz M, Vettorazzi E, Abboud T, Regelsberger J, Westphal M, Schmidt NO. Impact of intraventricular hemorrhage measured by Graeb and LeRoux score on case fatality risk and chronic hydrocephalus in aneurysmal subarachnoid hemorrhage. Acta Neurochir (Wien). 2015 Mar;157(3):409-15. doi: 10.1007/s00701-014-2334-z. Epub 2015 Jan 21. PubMed PMID: 25599911.

Bae IS, Yi HJ, Choi KS, Chun HJ. Comparison of Incidence and Risk Factors for Shunt-dependent Hydrocephalus in Aneurysmal Subarachnoid Hemorrhage Patients. J Cerebrovasc Endovasc Neurosurg. 2014 Jun;16(2):78-84. doi: 10.7461/jcen.2014.16.2.78. Epub 2014 Jun 30. PubMed PMID: 25045646; PubMed Central PMCID: PMC4102754.

Sugawara T, Maehara T, Tadashi N, Aoyagi M, Ohno K. Independent predictors of shunt-dependent normal pressure hydrocephalus after aneurysmal subarachnoid hemorrhage. J Neurosurg Sci. 2014 Jul 29. [Epub ahead of print] PubMed PMID: 25069541.

Zaidi HA, Montoure A, Elhadi A, Nakaji P, McDougall CG, Albuquerque FC, Spetzler RF, Zabramski JM. Long-term functional outcomes and predictors of shunt-dependent hydrocephalus after treatment of ruptured intracranial aneurysms in the BRAT trial: revisiting the clip vs coil debate. Neurosurgery. 2015 May;76(5):608-13; discussion 613-4; quiz 614. doi: 10.1227/NEU.000000000000677. PubMed PMID: 25714521.

Wang JY, Jackson EM, Jallo GI, Ahn ES. Shunt revision requirements after posthemorrhagic hydrocephalus of prematurity: insight into the time course of shunt dependency. Childs Nerv Syst. 2015 Nov;31(11):2123-30. doi: 10.1007/s00381-015-2865-5. Epub 2015 Aug 7. PubMed PMID: 26248674.

Gerner ST, Kuramatsu JB, Abel H, Kloska SP, Lücking H, Eyüpoglu IY, Doerfler A, Schwab S, Huttner HB. Intraventricular fibrinolysis has no effects on shunt dependency and functional outcome in endovascular-treated aneurysmal SAH. Neurocrit Care. 2014 Dec;21(3):435-43. doi: 10.1007/s12028-014-9961-3. PubMed PMID: 24566979.

Schmieder K, Koch R, Lücke S, Harders A. Factors influencing shunt dependency after aneurysmal subarachnoid haemorrhage. Zentralbl Neurochir. 1999;60(3):133-40. PubMed PMID: 10726336.

Engel M, Carmel PW, Chutorian AM. Increased intraventricular pressure without ventriculomegaly in children with shunts: "normal volume" hydrocephalus. Neurosurgery. 1979 Nov;5(5):549-52. PubMed PMID: 534062.

11)

Epstein FJ, Hochwald GM, Wald A, Ransohoff J. Avoidance of shunt dependency in hydrocephalus. Dev Med Child Neurol Suppl. 1975;(35):71-7. PubMed PMID: 812752.

Dong F, Wang Z, Li Y, Chen Z, Zhang S, Wan F. Shunt Dependency Syndrome after Cyst-Peritoneal Shunt Resolved by Keyhole Microsurgical Cyst Resection: Two Case Reports and Literature Review. Neuropediatrics. 2018 Jul 12. doi: 10.1055/s-0038-1661395. [Epub ahead of print] PubMed PMID: 30001565.

Sonobe M, Kodama N, Fujiwara S, Takaku A, Suzuki J. [On-off mechanism of shunt system due to slit ventricle (author's transl)]. No Shinkei Geka. 1978 Dec;6(12):1193-6. Japanese. PubMed PMID: 732936.

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