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CBF evaluation as a diagnostic tool in hydrocephalus diagnostic

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SUMMARY

The diagnosis of chronic hydrocephalus, - especially NPH -, and the discrimination from other kinds of cerebral atrophy may be difficult. Even sophisticated diagnostic regimes are not able to provide a correct estimation of the result of shunting procedure in every case. Shunt surgery in cases of not hydrocephalic cerebral atrophy may have catastrophic sequels. Therefore the development of further diagnostic criteria of shunt-requiring hydrocephalus was necessary. It was known, that cerebral blood flow (CBF) increases after shunt operation in patients suffering from hydrocephalus and responding to operation and decreases in patients with cerebral atrophy not responding to surgery. In 14 patients suffering from the classical symptoms of NPH, CBF was evaluated before and after diagnostic CSF removal using Xenon CCT. We found, that a CBF increase after CSF removal may be a good hint, but an absent reaction may not exclude successful shunting surgery.

INTRODUCTION

Recent papers from well-known authorities (1, 18, 19) in shunting surgery document a frustrating low success rate after shunting in suspected normal-pressure hydrocephalus (NPH). Thereby the consequences of a not indicated shunt operation can be dramatic and sometimes may result in the patient's death (12, 18).
We don't belief, that a more sophisticated ICP monitoring, but only metabolic data will enhance the clinical security in hydrocephalus diagnostics. Recent studies in experimental hydrocephalus revealed clear metabolic differences between hydrocephalic and normal subjects (4). However the technics are new and actually not available everywhere.

Earlier studies (13, 16, 20) and own experiences (7) revealed, that the CBF decreases in a multitude of cerebral atrophic conditions. In cases of NPH, CBF may increase after shunting procedure (7, 11, 13, 14, 15, 16, 20). It is believed, that this is secondary to an increased cerebral metabolism after shunting (14, 15).
The objective of the study was to illuminate the value of CBF measurement as a simple, not-invasive tool in differential diagnosis of NPH, as a first trial of using (indirect) metabolic data for this purpose.

MATERIAL AND METHODS

14 patients suffering from the classical symptoms of NPH were examined. The decision for shunting therapy (VA-Hakim high-high pressure valve (Cordis Medizinische Apparate GmbH, Haan, Germany ®, range 160 - 180 mm Hg)) based on clinical and ICP data according to Gjerris' criteria (2, 3). Each patient was submitted to a 3 days lasting continuos ICP monitoring, and a determination of the resistance to outflow (ROF) (5, 6, 10). A Spiegelberg III ® sensor was used for intraventricular ICP monitoring. Data were analysed and stored on hard disk drive on a Pentium® PC using PC-ICP® (Vers.: 2.8) (6) under Windows95®. Regional CBF (rCBF) was determined by a Xenon CCT on a GE CT 9800 (General Electrics, Milwaukee, USA ®) and a stable-Xenon gas enhancer (Enhancer 3000, DDP, Texas, USA ®) before and after CSF removal. After application of a mixture of 30 Vol% stable Xe gas and 70 Vol% O_2 over 4.5 min. the rCBF of two slices at the level of basal ganglia could be computed. CSF was drained via the Spiegelberg III® device resulting in a CSF removal of at least 40 ml. The clinical condition of the patients were determined according to Tab. 1 before and 1 week after shunting. Statistic tests: Wilcoxen matched pair (α= 5), Pearson CorrelationCoefficient test (α=5)

Tab1.: „Homburger Hydrocephalus Scale“ for clinical scoring of patients

score	mental	gait	incontinence	headache	vertigo
0	no deficit	no deficit	no deficit	no pain	no vertigo
1	forgetfulnes, concentration disturbance	only in special tests gait disturbances	temporary bladder incontinence	intermittent or slight permanent pain	only under provocation
2	apathy, partially orientated	ataxic, wide legged gait	permanent bladder incontinence	permanent strong pain	intermittent vertigo in daily life
3	totally disorientated	gait only with crutches	urine and defecation incontinence		permanent vertigo
4		only a few steps with aid of a person			
5		unable to go			

RESULTS

Four patients did not fulfil shunting criteria. In these mean CBF before CSF removal (basal examination) was 27.3 ml/ 100 mg/ min (±4.2 ml / 100 mg /min) and after CSF removal 26.1 ml / 100 mg/ min (± 6.1 ml/ 100 mg /min). The value before CSF removal did not differ significantly from basal examination of patients, who fulfilled shunting criteria. Non of these patients, suspected to suffer from an atrophic condition and not from an active NPH according to Gjerris'criteria, showed an CBF amelioration after CSF removal. In two patients the value remained the same before and after CSF drainage, in the others CSF drainage induced a CBF decrease.

Ten patients were shunted. Clinically all shunted patients improved statistically significant according to our grading scale from preoperatively 7.4 (±0.8) to 3.2 (± 1.1) postoperatively. Eight of the shunted patients had a ROF > 12 mm Hg /ml/ min and B-waves occurred in more than 50% of ICP registration time. The two remaining patients also revealed B-waves in over 50% of monitored time, but had a normal (< 12 mm Hg / ml/ min) ROF. One of these had no amelioration of CBF after CSF removal, but did clinically well. No correlation was found for B-wave frequency and ROF, and for B-wave frequency or ROF and clinical outcome.

The shunted patients showed a statistically significant amelioration of rCBF, from basal examination 27.6 (± 2.7) ml /100 mg / min to indication examination 43.8 (± 6.4) ml / 100 mg/ min. The individual CBF changes after CSF removal ranged in this group from - 12.8% (= 3.6 ml/ 100 mg / min) to + 86% (= 42.0 ml / 100 mg/ min). No statistically significant correlation, but a clearly positive trend was found between CBF changes after CSF removal and clinical outcome. No correlations existed between basal examination CBF and measured mean ICP respectively B-wave frequency or ROF. Similar there was no correlation between these ICP data (mean value, ROF, B-wave frequency) and CBF changes induced by CSF removal.

DISCUSSION AND CONCLUSIONS

Successful shunting depends not on a ventricular size reduction (8, 17). This clearly shows, that it is the cerebral metabolism, which may be the key point for an overall understanding of hydrocephalus pathophysiology. Accordingly the criteria for successful shunting have to be searched at the level of cerebral metabolism. Our result, that in cases of NPH CBF increases after CSF removal, is in accordance with earlier studies (14, 15). Similar the not existing correlation between CBF and clinical performance before CSF removal was also found in other studies (13, 14, 15). The underlying pathophysiology seems to be a lack of autoregulation of the cerebral vessels, which may be restored after ICP reduction. However it is to discuss to which amount additional cerebral diseases may influence the result (e.c. arteriosclerosis). Otherwise a stenosis of cerebral vessels may reduce a potential CBF increase in NPH, so that a clinical benefit may not occur. The primary impaired parameter, - CBF or cerebral metabolism -, is not to identify. Accordingly the influence of other diseases is actually not clear.

At the moment the role of CBF evaluation in hydrocephalus diagnostics is, that a positive reaction to CSF removal seems to be a good hint, but a negative result may not exclude successful shunting. To clarify the value of the method long-term outcome has to be correlated with CBF changes by CSF drainage. Moreover the time of CSF drainage necessary to allow every patient, who could have benefit from shunting, to improve CSF, has to be studied systematically.

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