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Zastosowanie badania neuropsychologicznego u chorego z wodogłowiem pokrwotocznym – opis przypadku

Application of neuropsychological assessment in a patient with posthaemorrhagic hydrocephalus – a case report

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Streszczenie

Wprowadzenie i cel: Wodogłowie pokrwotoczne należy do najpoważniejszych powikłań krwotoku podpajęczynówkowego. Najczęstszą przyczyną krwotoku podpajęczynówkowego jest pęknięty tętniak wewnątrzczaszkowy. Objawy kliniczne i neuropsychologiczne wodogłowia pokrwotocznego obejmują głównie apraksję chodu, nietrzymanie moczu i różne zaburzenia neuropoznawcze. Głównym leczeniem neurochirurgicznym wodogłowia pokrwotocznego jest wszczepienie zastawki komorowo-otrzewnowej. Celem pracy była analiza neuropsychologicznego funkcjonowania pacjenta z wodogłowiem pokrwotocznym, opis dynamiki zmian poznawczych w przebiegu wodogłowia, jak również podkreślenie znaczenia diagnozy neuropsychologicznej w planowaniu interwencji neurochirurgicznej. **Materiał i metody:** W artykule przedstawiono przypadek 52-letniego mężczyzny, u którego stwierdzono krwotok podpajęczynówkowy po pęknięciu tętniaka tętnicy łączącej przedniej. Po operacji pacjent prezentował poważne deficyty pamięci epizodycznej, był okresowo nielogiczny i zdezorientowany. Badanie neuropsychologiczne, przeprowadzone za pomocą testów Addenbrooke's Cognitive Examination III (ACE-III) w wersjach równoległych i Trail Making Test A i B (TMT-A i TMT-B), wykazało pogorszenie szybkości psychomotorycznej, osłabienie koncentracji uwagi oraz zaburzenia funkcji wykonawczych. **Wyniki:** W związku ze stopniową poprawą stanu neurologicznego pacjent został wypisany ze szpitala, jednak po czterech miesiącach od operacji chorego przyjęto ponownie z powodu apraksji chodu, upośledzenia funkcji poznawczych i wykonawczych w badaniu neuropsychologicznym oraz cech wodogłowia w tomografii komputerowej. U pacjenta wykonano wszczepienie zastawki komorowo-otrzewnowej, jednak w związku z podejrzeniem jatrogennego zapalenia otrzewnej usunięto system zastawki komorowo-otrzewnowej. U chorego stwierdzono nawrót objawów klinicznych i neuropsychologicznych i konieczna była reimplantacja zastawki komorowo-otrzewnowej. Operację przeprowadzono po siedmiu tygodniach. W przebiegu pooperacyjnym i badaniach kontrolnych pacjent ponownie w pełnym kontakcie słowno-logicznym, nie wykazywał pogorszenia funkcji poznawczych i nie zgłaszał żadnych zaburzeń klinicznych. **Wnioski:** Zaprezentowany opis przypadku wskazuje na znaczenie oceny neuropsychologicznej w diagnostyce wodogłowia pokrwotocznego. Zaprezentowano charakterystykę kliniczną i psychologiczną pacjenta z wodogłowiem zależnym od wszczepionej zastawki, z obecnością objawów neuropsychiatrycznych. Niniejsza praca wykazuje, że badanie neuropsychologiczne cechuje wysoka czułość w wykrywaniu nawet subtelnych zmian w zakresie funkcjonowania poznawczego oraz emocjonalnego pacjenta z wodogłowiem, które stanowią wczesny sygnał pogarszania się stanu neurologicznego i zmian w zakresie układu komorowego.

Słowa kluczowe: wodogłowie pokrwotoczne, krwotok podpajęczynówkowy, wodogłowie zależne od zastawki, deficyty neuropoznawcze, badanie neuropsychologiczne

Abstract

Introduction and objective: Posthaemorrhagic hydrocephalus constitutes one of the most serious complications of subarachnoid haemorrhage. The most common cause of subarachnoid haemorrhage is a ruptured intracranial aneurysm. Clinical and neuropsychological presentations of the posthaemorrhagic hydrocephalus include mainly gait apraxia, urinary incontinence, and various neurocognitive impairments. The main neurosurgical treatment of the posthaemorrhagic hydrocephalus is ventriculoperitoneal shunt implantation. The study aimed to analyse the neuropsychological functioning of a patient with post-haemorrhagic hydrocephalus, describe the dynamics of cognitive changes during hydrocephalus, and

emphasise the importance of neuropsychological diagnosis in planning neurosurgical intervention. **Materials and methods:** In this article, we report a case of a 52-year-old male patient, who suffered from subarachnoid haemorrhage after an anterior communicating artery complex aneurysm rupture. After the surgery, the patient presented with massive episodic memory deficits, periodical illogicality, and disorientation. Neuropsychological examination, conducted using Addenbrooke's Cognitive Examination III (ACE-III) in parallel versions and the Trail Making Test A and B (TMT-A and TMT-B), showed deterioration of psychomotor speed, decreased concentration of attention and impaired executive functions. **Results:** Due to the gradual neurological condition improvement, the patient was discharged from the hospital but four months after the surgery, he was readmitted with gait apraxia, a decline in cognitive and executive functions in neuropsychological examination, and radiological signs of hydrocephalus in the computed tomography. The patient underwent a ventriculoperitoneal shunt implantation, but due to the suspicion of iatrogenic peritonitis, the ventriculoperitoneal shunt system was removed. The recurrence of the clinical and neuropsychological symptoms was observed and ventriculoperitoneal shunt reimplantation was necessary. The surgery was performed after seven weeks. In the postoperative course and follow-up examination, the patient was again in logical contact, did not show any cognitive decline and did not present any clinical disturbances. **Conclusions:** Thus, we demonstrated the importance of neuropsychological assessment in the diagnosis of posthaemorrhagic hydrocephalus and the clinical and psychological characteristics of the patient with shunt-dependent hydrocephalus with the presence of neuropsychiatric symptoms. This study shows that neuropsychological examination is highly sensitive to detection of subtle changes in the cognitive and emotional functioning of a patient with hydrocephalus, which are early signs of deterioration of the patient's neurological condition and changes in the ventricular system.

Keywords: posthaemorrhagic hydrocephalus, subarachnoid haemorrhage, shunt-dependent hydrocephalus, neurocognitive impairment, neuropsychological assessment

INTRODUCTION

Posthaemorrhagic hydrocephalus (PHH) is defined as progressive ventricular enlargement and elevated intracranial pressure (Lolansen et al., 2022). Disturbances in cerebrospinal fluid (CSF) flow or absorption following haemorrhagic events such as intraventricular haemorrhage (IVH) and subarachnoid haemorrhage (SAH) (Chen et al., 2017). IVH and SAH are the most often mentioned causes of PHH, however, those are not the only conditions that can lead to PHH. It is also noticeable that PHH can develop from traumatic brain injury and occurs as a complication in 35% of cases after non-aneurysmal subarachnoid haemorrhage (Chen et al., 2017; Wolfert et al., 2022). There is a study on the risk factors of PHH, which includes cases of cerebral haemorrhage and SAH. The results revealed that hydrocephalus did not correlate with sex, age, bleeding location and type, and previous medical history (Wang et al., 2022).
Hydrocephalus mentioned may occur at any age ranging from prematurity to adulthood. Almost one-third of neonates who experienced IVH will develop PHH, while in adults it is two-thirds of patients with IVH. Even though the aetiology of IVH in these groups is different, both groups are at risk of developing PHH and the treatment of PHH stays the same (Lolansen et al., 2022). Unfortunately, there are no methods of effective prevention strategies for PHH, despite how devastating the condition can be (Chen et al., 2017).
Common consequences of PHH include cognitive impairment, gait apraxia, and urinary incontinence (Chen et al., 2017; Wang et al., 2022). Patients affected by PHH typically undergo a gradual onset of progressive gait impairment accompanied by varying degrees of cognitive and/or urinary dysfunction. In chronic hydrocephalus following SAH, poor neurological outcomes and severe neurocognitive deficits have been reported (Kuo and Huang, 2021). Frequent neurocognitive impairment in patients with PHH include memory, language and executive functions (Al-Khindi et al., 2010). The Tap Test, also recognised as the large-volume lumbar puncture, stands as a key diagnostic tool for PHH. This procedure entails evaluating and recording the patient's gait, followed by a lumbar puncture (LP) extracting 30–50 mL of CSF. Subsequently, a reassessment of the patient's gait is performed 2–4 hours after the LP (Williams and Malm, 2016). The only method of treating PHH remains surgical interventions such as temporary external ventricular drainage, endoscopic third ventriculostomy or permanently implanted CSF shunts (Holste et al., 2022). Therefore, in the literature, that condition is described as shunt-dependent hydrocephalus after SAH (Paisan et al., 2018). One of the longest-used methods as a mainstay of treatment for PHH remains CSF shunting, including ventriculoperitoneal shunts (VPS) and lumboperitoneal shunts (LPS). In predicting the benefits of potential CSF shunt implantation, the Tap Test described above is often used (Ferrari et al., 2020). Despite VPS shunt being the most common treatment for PHH, while LPS serves as an effective alternative method, neurosurgeons choose LPS due to the lower risk of brain damage and infection compared to VPS. This condition places neonates and adults at risk for white matter injury, and seizures and it is also associated with increased morbidity and mortality (Sun et al., 2021).

CASE DESCRIPTION

A 52-year-old male patient with higher education was admitted to the Department of Neurosurgery, Spine and Peripheral Nerve Surgery on October 4, 2022, due to severe head pain reported at night. Neurological and radiological

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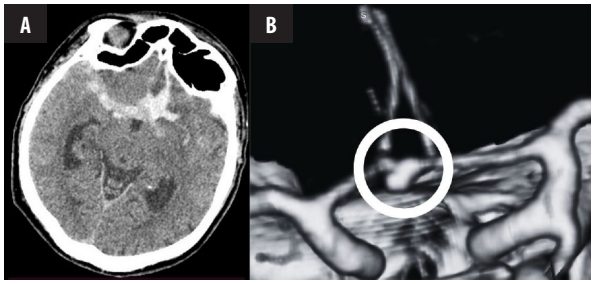

Fig. 1. **A.** *Subarachnoid haemorrhage (SAH) in the head CT scan.* **B.** *Three-dimensional reconstruction from the CT angiography with the anterior communicating artery (AComA) complex aneurysm (white circle)*

(computed tomography – CT scan and CT angiography of the head) assessments were performed. The patient was drowsy and periodically confused, he had 14 points in the Glasgow Coma Scale, and he also reported neck stiffness. The diagnosis of massive SAH due to rupture of an anterior communicating artery (AComA) complex aneurysm was made (Fig. 1 A, B).

The patient underwent a right-sided lateral supraorbital craniotomy with clipping of the AComA aneurysm. In the postoperative course, the patient experienced a cerebral vascular spasm, which responded to implemented pharmacotherapy. In the following days, the patient was in good general condition but was periodically illogical. Hence, neuropsychological, and psychiatric consultations were ordered. Screening tests: Addenbrooke's Cognitive Examination III (ACE-III) in parallel versions and Trail Making Test A and B (TMT-A and TMT-B) were used to evaluate and monitor his condition – the results are presented in Tab. 1, in Figs. 2 and 3. The patient was conscious though periodically illogical, disoriented as to the place and time, with massive episodic

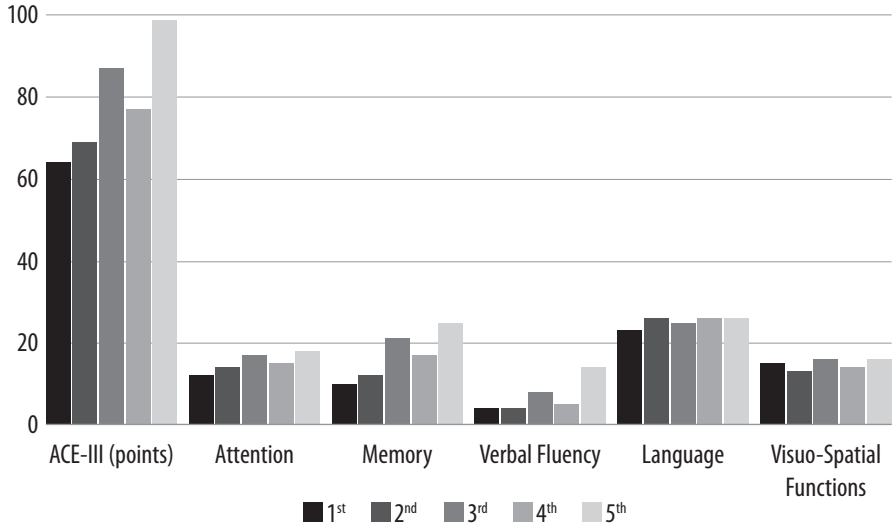

Fig. 2. Addenbrooke's Cognitive Examination III (ACE-III) results

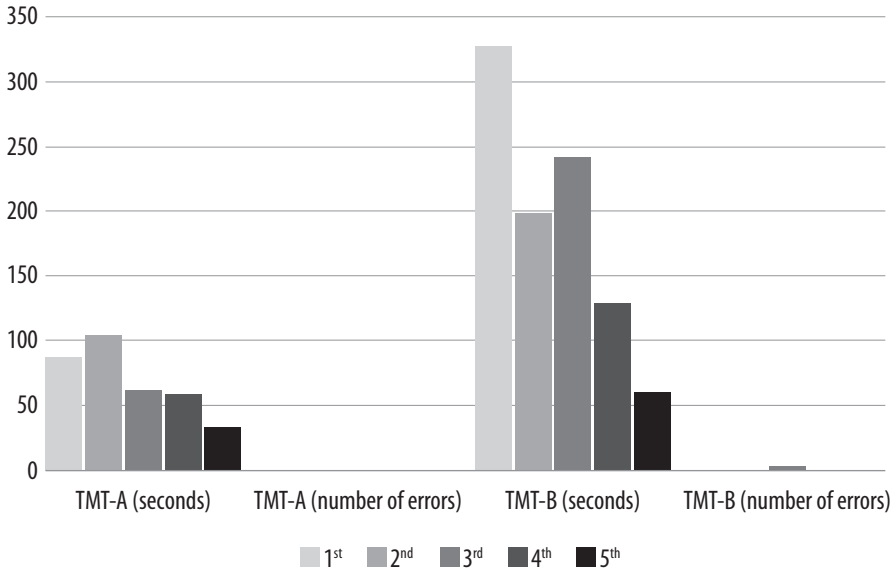

Fig. 3. Trail Making Test A and B (TMT-A and TMT-B) results

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Neuropsychological assessment	1st	2nd	3rd	4th	5th
ACE-III (points)	64	69	87	77	99
Attention	12	14	17	15	18
Memory	10	12	21	17	25
Verbal Fluency	4	4	8	5	14
Language	23	26	25	26	26
Visuo-Spatial Functions	15	13	16	14	16
TMT – A (seconds/number of errors)	88/0	106/0	62/0	59/0	34/0
TMT – B (seconds/number of errors)	328/0	199/0	242/3	129/0	61/0

Tab. 1. The results of screening neuropsychological tests performed subsequently

memory deficits. There were numerous confabulations in his statements. He periodically presented inappropriate affect with a tendency to moria. He was uncritical towards his health condition. Neuropsychological examination revealed worsening/deterioration of psychomotor speed, poor attention, executive function impairments (planning, difficulties generating and implementing strategies, inability to utilize feedback, and inflexibility of thinking), as well as memory and learning deficits (1st). After the gradual improvement of the patient's neurological condition, he was discharged from the hospital after 30 days of hospitalisation. Four months after the surgery, the patient was readmitted with gait apraxia, neurocognitive disturbance and ventricular enlargement revealed in the head CT scans (Fig. 4).

In neuropsychological assessment: again, he was disoriented as to the place and time, with confabulations in his statements and presented inappropriate affect. The patient revealed deterioration of psychomotor speed, worsening of attention, executive function as well as memory and learning. An initial gait assessment and Tap Test were performed. In the follow-up evaluation, a gait improvement was obtained. Two days after that, the Tap Test was repeated with similar results. Furthermore, neuropsychological, and psychiatric assessments showed a decline in cognitive and executive functions, disorientation to the place and time, and elevated mood/affect (2nd). After prior qualification, a VPS implantation was performed. In the next few days, his general condition was good, and he was discharged from the hospital. Two weeks later the patient was admitted to the Department of General Surgery due to suspicion of peritonitis. He underwent a diagnostic laparotomy. To avoid the risk of ascending infection, the patient was qualified for removal of the VPS and antibiotic therapy was ordered. His cognitive, emotional, and behavioural evaluation was repeated (3rd). Further treatment was continued in the Department of Infectious Diseases. VPS reimplantation was planned and took place seven weeks later (Fig. 5).

His neuropsychiatric symptoms disappeared, and cognition improved (4th). In the follow-up, three months after surgical intervention, neurological disturbances were not observed. Furthermore, the neuropsychological assessment revealed no deficits: the patient was in logical contact, correctly oriented in all directions, and did not show any cognitive

Fig. 4. Ventricular enlargement in the CT scan of the head

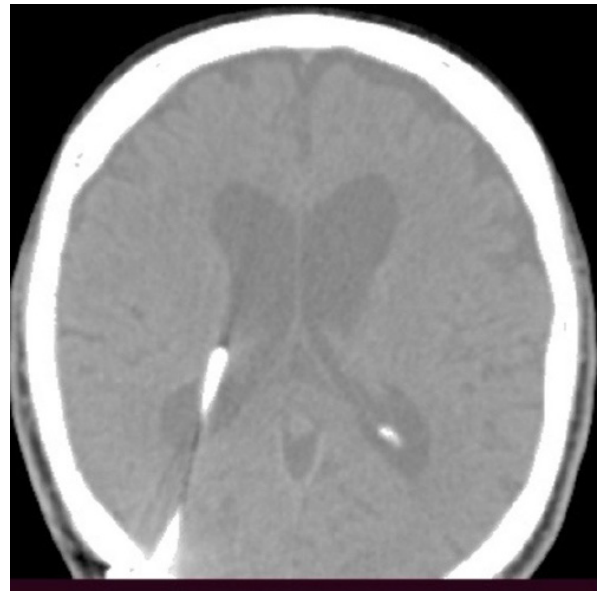

Fig. 5. Reimplanted ventriculoperitoneal shunt (VPS) in the control CT scan

decline (5th). The patient did not require neuropsychological rehabilitation.

DISCUSSION

The presented case describes PHH after aneurysmal SAH in an adult patient. As far as neuropsychological examination is concerned, the patient presented with neuropsychiatric symptoms as well as executive and cognitive deficits which fluctuated accordingly to neurosurgical treatment. These dysfunctions flourished and were of high diagnostic importance accompanying the PHH development.

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SAH is frequently associated with various cognitive dysfunctions in the acute and chronic phases however PHH and especially shunt-dependent hydrocephalus are considered poor long-term prognostic factors in that group of patients (Haug Nordenmark et al., 2019; Nwafor et al., 2023; Paisan et al., 2018).

The neuropsychological deficits were coherent with those described in some other studies (Zaksaite et al., 2023) and were related to memory, attention, executive functions, and processing speed. However, the presented neuropsychiatric symptoms (like disorientation towards time and place, illogicality, and confabulations) are rarely described in the literature. These symptoms were of high importance for the diagnosis and influenced the decision to perform VPS implantation.

The results of neurosurgical treatment induced total remission of neuropsychiatric symptoms and neuropsychological dysfunctions. These may suggest the diagnosis of shunt-dependent hydrocephalus after SAH which constitutes PHH sequela in approximately 13 to 14% of patients with aneurysmal SAH (Hao and Wei, 2019; Paisan et al., 2018).

CONCLUSIONS

In the described case, we highlighted the important role of the neuropsychological assessment in the patient with PHH development after aneurysmal SAH. It is worth emphasising the presence of neurocognitive and neuropsychiatric symptoms in the diagnostics of PHH. Moreover, our study provides the clinical and neuropsychological characteristics of the patient with shunt-dependent hydrocephalus also suggesting that neuropsychological examination is highly sensitive to subtle changes in the cognitive and emotional functioning of such patient. These changes frequently are early signs of deterioration of the patient's neurological condition and changes in the ventricular system.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organisations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

Author contributions

Original concept of study: AP. Collection, recording and/or compilation of data: AP, JJ, RT, KK, WL. Writing of manuscript: AP, KK, WL. Critical review of manuscript: MB, MW, MR. Final approval of manuscript: AP, JJ, RT, KK, WL, MB, MW, MR.

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