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Agnieszka Pawełczyk[1], Karol Jastrzębski[2], Maciej Radek[1], Tomasz Pawełczyk[3]

Neuropsychiatric and neuropsychological deficits in a 33-year-old woman with chorea-acanthocytosis. A case report and a literature review

Neuropsychiatryczne i neuropsychologiczne deficyty obserwowane u 33-letniej kobiety w przebiegu choreoakantocytozy. Opis przypadku i przegląd literatury

[1] Chair of Surgery, Department of Neurosurgery, Spine Surgery and Peripheral Nerves Surgery, Medical University of Lodz, Łódź, Poland
[2] Department of Neurology and Epileptology, Stroke Department, Medical University of Lodz, Łódź, Poland
[3] Chair of Psychiatry, Department of Affective and Psychotic Disorders, Medical University of Lodz, Łódź, Poland
Correspondence: Agnieszka Pawełczyk, MA, PsyD, Chair of Surgery, Department of Neurosurgery, Spine Surgery and Peripheral Nerves Surgery, Medical University of Lodz, Żeromskiego 113, 90-549 Łódź, Poland, e-mail: agnieszka.pawelczyk@umed.lodz.pl
Dr n. hum. Agnieszka Pawełczyk, Katedra Chirurgii, Klinika Neurochirurgii, Chirurgii Kręgosłupa i Nerwów Obwodowych, Szpital im. WAM, ul Żeromskiego 113, 90-549 Łódź, e-mail: agnieszka.pawelczyk@umed.lodz.pl

Abstract

Neuroacanthocytosis – phenotypically and genetically heterogeneous disorders associated with acanthocytosis – are a group of abnormalities which affect the basal ganglion, causing movement disorders, other neurological symptoms and also cognitive and neuropsychiatric impairments. There are few reports on neuropsychiatric and neuropsychological symptom development in the course of the disease. We described a 33-year-old female patient, who was diagnosed with chorea-acanthocytosis associated with neurological, psychiatric and neuropsychological disorders. The neurological disorders included increasing involuntary movements of face and tongue, upper limb chorea, dysarthric speech, slight upper limb deep reflexes, vivid knee jerks, tonic-clonic seizures and absence of Achilles reflexes. Psychiatrically, she was depressed and presented with obsessive thinking. Neuropsychological assessment revealed increasing dysfunctions of attention, immediate memory, learning, verbal fluency, praxia, calculia and difficulties in adjusting behaviour to environmental conditions and in flexible correction of wrong responses. Neuropsychiatric and neuropsychological dysfunctions should be considered in the differential diagnosis to ensure proper diagnosis and management, especially when differentiating disorders in patients with neuropsychiatric symptoms, chorea, or in the case of late (in adulthood) onset of Tourette's syndrome.

Keywords: acanthocytes, cognition, cognitive decline, movement disorder, neuroacanthocytosis

Streszczenie

Neuroakantocytoza – fenotypowo i genetycznie niejednorodne zaburzenia związane z akantocytozą – obejmuje grupę nieprawidłowości uszkadzających zwoje podstawne i powodujących zaburzenia ruchowe, inne objawy neurologiczne, a także zaburzenia poznawcze i neuropsychiatryczne. Niewiele jest doniesień na temat rozwoju objawów neuropsychiatrycznych i neuropsychologicznych w przebiegu tej choroby. W artykule przedstawiono przypadek 33-letniej pacjentki, u której zdiagnozowano choreoakantocytozę związaną z zaburzeniami neurologicznymi, psychiatrycznymi i neuropsychologicznymi. Zaburzenia neurologiczne obejmowały: nasilenie mimowolnych ruchów twarzy i języka, pląsawicę kończyn górnych, dyzartrię, osłabienie odruchów głębokich kończyn górnych, żywe szarpnięcia kolan, napady toniczno-kloniczne i brak odruchów Achillesa. W badaniu psychiatrycznym pacjentka była depresyjna i doświadczała obsesyjnych myśli. Ocena neuropsychologiczna wykazała narastające dysfunkcje w zakresie: uwagi, bezpośredniej pamięci i uczenia się, fluencji słownej, praksji, kalkulii, trudności w dostosowywaniu zachowania do warunków środowiskowych oraz w plastycznej korekcie nieprawidłowych odpowiedzi. W diagnostyce różnicowej należy brać pod uwagę dysfunkcje neuropsychiatryczne i neuropsychologiczne – mogą one wspomóc właściwą diagnozę i leczenie. Szczególnie pomocne mogłyby być w różnicowaniu zaburzeń u pacjentów z objawami neuropsychiatrycznymi, pląsawicą lub w przypadku późnego (w dorosłości) wystąpienia zespołu Tourette'a.

Słowa kluczowe: akantocyty, funkcje poznawcze, obniżenie funkcjonowania poznawczego, zaburzenia ruchowe, neuroakantocytoza

INTRODUCTION

Acanthocytosis refers to abnormal red blood cells (RBCs) with irregular, long, spiculated cytoplasmic creations on the peripheral blood smear. These abnormal blood cells are often confused with echinocytes (or burr cells), which resemble burdock flower heads (burrs) (Zeman and Shenton, 2004) characterised by hooked scales. Both types of blood cells may coexist in neuroacanthocytosis and other diseases in one patient (Brecher and Bessis, 1972). The term "acanthocytosis" originated from Greek "acantho" or "acanthe" – meaning thorn (Min et al., 2010; Shannon, 2004).

If accompanied by involuntary movements, such a condition has been called Levine–Critchley syndrome since the 70's of the last century (Critchley et al., 1968; Levine, 1964). However, names used by these authors and coauthors are not uniform, which leads to chaos in nomenclature.

The term "neuroacanthocytosis" refers to a group of phenotypically and genetically heterogenous disorders accompanied by neurologic symptoms associated with acanthocytosis. The term is not precise and has led to many misunderstandings. Previously, it was used for inherited disorders of lipoprotein synthesis (abetalipoproteinaemia and hypobetalipoproteinaemia), in which impaired vitamin E absorption is present, causing degeneration of the posterior column of the spinal cord and cerebellum. At present, the term refers only to a group of abnormalities which affect basal ganglia, causing movement disorders (Dulski et al., 2016; Velayos Baeza et al., 2002; Walker et al., 2007). Tab. 1 presents symptoms observed in neuroacanthocytosis. The table is based on Jung et al. (2009).

The article focuses only on the basic neuroacanthocytosis groups: chorea-acanthocytosis (ChAc), McLeod syndrome (MLS), Huntington's disease-like 2 (HDL2) and pantothenate kinase-associated neurodegeneration (PKAN).

In Tab. 2 we present main diagnostic findings in the basic neuroacanthocytosis groups. The table is based on Jung et al. (2009).

ChAc

ChAc is a neurodegenerative, hereditary disease considered an autosomal recessive disorder. Neurological symptoms most commonly appear in the twenties. Many patients present with a characteristic phenotype: feeding dystonia with tongue protrusion when in contact with food, orofacial dyskinesias, involuntary movements of the face and tongue, dysarthria as a deficit of speech, involuntary tongue/lip biting. Gait resembles "rubber man" (unstable trunk, sudden violent trunk spasms) (Komiya et al., 2018; Liu et al., 2018; Peikert et al., 2018; Schneider et al., 2017; Velayos Baeza et al., 2002; Walker et al., 2007). In most cases, generalised chorea is observed, which many be difficult to differentiate from that in Huntington

Basic: 1. Chorea-acanthocytosis (ChAc) 2. McLeod syndrome (MLS) 3. Huntington's disease-like 2 (HDL2) 4. Pantothenate kinase-associated neurodegeneration (PKAN including HARP)
Acanthocytosis in systemic diseases where neurological findings may also be present: 1. Serious emaciation (e.g. anorexia nervosa) 2. Sarcoma 3. Thyroid disorders, myxoedema 4. Splenectomy 5. Hepatic cirrhosis, liver encephalopathy 6. Psoriasis 7. Eales' disease (juvenile retinal angiopathy) 8. MELAS
Neuroacanthocytosis with lipoprotein disorders: 1. Abetalipoproteinemia (Bassen–Kornzweig syndrome) 2. Familial hypobetalipoproteinemia 3. Anderson's disease (hereditary chylomicron retention disease characterised by deficiency of lysosomal enzyme – α-galactosidase) 4. Atypical Wolman disease
HARP – hypoprebetalipoproteinaemia, acanthocytosis, pigmentary retinitis, pallidal degeneration; **MELAS** – mitochondrial encephalopathy with lactic acidosis and stroke-like episodes.

Tab. 1. Neuroacanthocytosis syndromes. Based on Jung et al. (2009)

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Disorder	ChAc	MLS	HDL2	PKAN
Genes	*VPS13A*	*XK*	*JPH3*	*PANK2*
Protein	Chorein	XK	Junctophilin	Pantothenate kinase
Inheritance	AR	X-linked	AD	AR
Acanthocytosis	Yes	Yes	Yes/no	Yes/no
CPK plasma levels	300–3,000	300–3,000	Normal	Normal
Neuroimaging	Striatal atrophy	Striatal atrophy	Striatal and cortical atrophy	"The eye of the tiger" iron deposits in globus pallidus
Age at onset (years)	20–30	30–60	20–40	Childhood
Chorea	Yes	Yes	Yes	Yes
Other motor disorders	Tongue and gait dystonia, tongue and lip biting, parkinsonism	Vocalisation	Dystonia, parkinsonism	Dystonia, parkinsonism, spasticity
Seizures	Generalised, focal	Generalised	None	None
Neuromuscular manifestations	Areflexia, weakness, atrophy	Areflexia, weakness, atrophy	None	None
Cardiological disorders	None	Atrial fibrillation malignant arrythmia, cardiomyopathy	None	None
Psychiatric disorders	ADHD, OCD, trichotillomania, schizophrenia-like syndrome, memory and performance disorders	Depression, schizophrenia-like syndrome, OCD, cognitive deficits	Personality and other disorders, progressive, cognitive deficits	Memory disorders
AR – autosomal recessive; **AD** – autosomal dominant.				

Tab. 2. Main diagnostic findings in the basic neuroacanthocytosis groups. Based on Jung et al. (2009)

disease. In a smaller number of patients, parkinsonism is also observed. Dystonias of lips, tongue, face and limbs are common. At least 1/3 of patients suffer from epileptic seizures, usually generalised, which are often the first symptoms of the disease. Memory and movement disorders are often present. Most patients develop psychiatric symptoms; usually schizophrenia-like psychoses or obsessive compulsive disorders (Estévez-Fraga et al., 2018).

ChAc progresses slowly over 15–30 years; however, sudden deaths due to epileptic seizures may occur. Brain neuroimaging shows progressive atrophy, especially within the head of caudate nucleus, less frequently in the globus pallidus or the substantia nigra.

In most patients, elevated levels of creatinine phosphokinase (CPK) are found.

Clinical muscle symptoms include the lack of reflex response, motor-sensory neuropathy, muscle weakness and atrophy. Muscle biopsy and electromyographic examination show neuropathic, less frequently myopathic, changes.

ChAc is caused by various mutations in 73 exon, *VPS13A* gene on chromosome 9, encoding chorein (intracellular protein), whose physiological function is not fully known (Rampoldi et al., 2001).

MLS

Most patients with the McLeod phenotype related to the absence of Kx antigen on RBCs and a weak expression of Kell antigens (which is incidentally found during a routine blood test), acanthocytosis and elevated CPK level develop full MLS (Allen et al., 1961; Jung et al., 2007, 2004; Komiya et al., 2018). Neurological symptoms develop between 25 and 60 years of age, and the disease usually

lasts from 10 to 30 years or longer. About 30% of patients develop chorea symptoms similar to those in Huntington's disease. Involuntary movements may also include orofacial dyskinesia and vocalisation. Psychiatric symptoms observed in MLS include depression, schizophrenia-like symptoms, and obsessive-compulsive disorders. They may be prodromal symptoms to motor disorders. Some patients, particularly in later stages, develop cognitive deficits (Roulis et al., 2018).

About half of the patients suffer from epileptic seizures. Elevated CPK concentration is almost always found. Neuroimaging shows selective striatum atrophy and glucose metabolism disorders within this structure. Neuropathological examinations demonstrate non-specific neuronal loss and gliosis, particularly in the caudate nucleus, less frequently in the putamen, the tegmentum and the globus pallidum. Neuromuscular disorders include neuromyopathy and sensory motor axonal neuropathy. Although half of the patients present muscle weakness and atrophy, serious gait disorders are rarely observed (Hewer et al., 2007). About 60% of patients present with cardiomyopathy with atrial fibrillation, malignant arrhythmia and dilated cardiomyopathy, which are a frequent cause of death (Oechslin et al., 2009; Walker et al., 2019).

MLS is thought to be a hereditary, X-linked genetic syndrome, which includes chronic granulomatous disease (inherited immunodeficiency caused by reduced nicotinamide adenine dinucleotide oxidase), Duchenne muscular dystrophy and/or X-linked pigmentary retinopathy.

MLS is caused by mutations in the *XK* gene encoding the XK protein, which carries the Kx RBC antigen. Most pathogenic mutations are nonsense mutations or deletions causing absence of shortening of the XK protein, whose role is not fully understood, and may play its role in apoptosis regulation (Allen et al., 1961; Danek et al., 2001; Ho et al., 1994; Jung et al., 2001; Stanfield and Horvitz, 2000).

HDL-2

HDL-2 is an autosomal dominant neurodegenerative disease (Hewer et al., 2007; Margolis et al., 2001; Stanfield and Horvitz, 2000). All affected families come from Africa. First symptoms appear at different ages and the disease lasts between 10 and 20 years. Initial symptoms include personality change or other psychiatric disorders. Later, motor disorders develop, most commonly chorea, parkinsonism and dystonias. Epileptic seizures or neuromuscular disorders are usually not observed (Walker et al., 2003). Acanthocytosis is found in only 10% of patients, CPK levels are normal. Neuroimaging demonstrates bilateral striatal atrophy, especially of the caudate nucleus and sometimes also cortical atrophy. Neuropathologically, the symptoms are similar to those observed in Huntington's disease. HDL-2 is caused by changes in trinucleotide repeats of junctophilin 3 gene (*JPH3*), which plays a crucial role in junctional membrane structures and calcium regulation.

PKAN

PKAN is a hereditary autosomal recessive disorder belonging to a group of disorders known as neurodegeneration with brain iron accumulation. Typically, PKAN develops in childhood and progresses over 10 years. Initial manifestations include dystonias within lips, face and limbs, chorea and muscle stiffness. Most patients develop pigmentary retinopathy, and worsening of cognitive function is observed in about 1/3 of patients. Only about 8% of patients have acanthocytosis possibly due to abnormalities of lipid synthesis. Neuroimaging shows characteristic changes – iron deposition ("eye-of-the-tiger") in the globus pallidus.

PKAN is caused by mutations in the pantothenate kinase 2 gene (*PANK2*) on chromosome 20p13, which takes part in the synthesis of coenzyme A from vitamin B_5 (Hayflick et al., 2003; Storch et al., 2005).

SUMMARY

Neuroacanthocytosis may be due to different causes. This diagnosis should be taken into consideration when differentiating disorders in patients with neuropsychiatric symptoms, chorea or in the case of late (in adulthood) onset of Tourette's syndrome. Tongue dystonia and typical feeding dystonia, tongue protrusion when in contact with food suggest neuroacanthocytosis. Various neurological symptoms may develop in the course of the disease including: epileptic seizures, motor neuron disorders, cognitive impairment and even dementia.

If 3% of acanthocytes are revealed in peripheral blood smear, the result is considered positive despite the fact that symptoms may not be present yet. Thus, the diagnosis of the described disorders is difficult as well as involves specific investigations and differentiation with Huntington's disease. The diagnosis is often based on negative genetic findings. Pharmacological treatment is symptomatic and rehabilitation is needed.

CASE STUDY

Case history

MS (her case was also presented in Jastrzębski et al., 2010) was born at term from the fourth pregnancy. Her Apgar score was: 3, 7, 8; she was in critical condition, with severe dyspnoea and bradycardia. Spherocytes were found in the blood sample. In the childhood, she often suffered from pneumonia, bronchitis and cold. She had been diagnosed with anaemia, microspherocytosis, hyperbilirubinemia and orthostatic hypotension prior to psychiatric treatment. She had no history of traumatic brain injury (TBI), strokes, central nervous system intoxication, nor was she asphyxiated with carbon monoxide. There was no family history of psychiatric treatment. On neurological

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consultation, she said her brother had speech difficulties and was diagnosed with acanthocytosis.

Order and time of symptom onset

MS first complained of coughing, hawking and spitting. She was consulted by a psychiatrist at the local Outpatient Clinic who diagnosed her symptoms as being of psychological origin. Her general condition worsened i.e. depressed mood, intensification of pessimistic thoughts, difficulties with concentrating and emotional tension were observed. Obsessive thoughts on self-depreciation and social withdrawal accompanied the symptoms. She was first hospitalised in a psychiatric ward with an initial diagnosis of obsessive-compulsive disorder (OCD) due to brain damage. The patient expressed ideas of reference, but she denied hallucinations. She complained of persistent fatigue and debility in everyday activities. She scored 30 points in Beck Depression Inventory (BDI) and was treated with sertraline 200 mg daily, olanzapine 5 mg daily, bromazepam 9 mg daily and injected haloperidol depot 0.5 g IM every two weeks. She was discharged from hospital with the diagnosis of OCD, with alleviated symptoms and recommended to report for a check-up at the Outpatient Clinic.

Then she complained of involuntary facial movements attributed to pharmacological treatment. She did not improve and her symptoms, such as cough and hawk, increased. According to the patient, the hawking was triggered by excessive saliva production, which irritated her throat. Subsequently, due to persistent symptoms, the patient was hospitalised with suspected depressive disorder, tics or paranoid symptoms. Physical examination revealed asymmetry of shoulder bones, skin changes and tooth loss. Neurological examination showed tongue dystonia, vocal tics and postural tremor of upper limbs, whereas psychiatric examination revealed energy decline, lack of pleasure, obsessive and resignation thoughts. The patient's appetite and sleep were normal, she denied having lowering mood, suicidal thoughts, psychotic symptoms or using psychoactive substances. She was given sertraline 50 mg/24 hours and bromazepam 3 mg/24 hours. Magnetic resonance imaging (MRI) was performed; however, no focal lesions were found. She was diagnosed with dyskinesia or functional symptoms. In hospital, we observed an increase in sorrow and depression, she had difficulty concentrating and was interested only in her health. The patient's sleep was disturbed. On neuropsychological assessment, deficiencies of attention, executive functions and verbal fluency were found.

During hospitalisation in the following year, the patient was administered sertraline 150 mg/24 hours, bromazepam 6 mg/24 hours, clonidine hydrochloride 0.3 mg/24 hours, tiapride 100 mg/24 hours, mianserin 45 mg/24 hours and citalopram 10 mg/24 hours. Pharmacological treatment was modified to avoid the risk of increased neurological symptoms; however, after reducing antidepressant doses, a depressive episode developed. MS was prescribed mianserin 45 mg/24 hours, citalopram 10 mg/24 hours, and tiapride 100 mg/24 hours. The patient was also started on psychotherapy, which improved her mood and activity. She was discharged from hospital still having involuntary movements and vocal tics.

Subsequent hospitalisation was due to seizures, initially diagnosed as pseudo-epileptic, and later found to be tonic-clonic. The causes of seizures, tics and involuntary movements posed serious difficulties, thus one of the diagnosis was: "suspected psychogenic movement disorder in the form of tics and pseudo-epileptic seizures." On the last neurological examination: involuntary facial, tongue and upper limb movements in the form of chorea, dysarthria, hypoactive deep reflexes R=L, hyperactive knee reflexes R=L, no ankle reflexes on both sides, tonic-clonic seizures were present.

Diagnostic difficulties

The clinical picture was unclear. The initial psychiatric symptoms suggested depression and obsessive – compulsive disorder. Electroencephalography (EEG), electrocardiography (ECG) and abdominal ultrasound (US) scan were normal. Elevated levels of reticulocytes (30%) and bilirubin (2.42 mg/dL, CPK = 177 U/L), spherocytes and single schistocytes were found. Genetic investigations did not confirm Huntington's disease. Gradually appearing dystonias were initially interpreted as functional or/and drug-induced. There were no focal symptoms, MRI scan was normal.

Medical records from 2006 showed no deviation from norm in biochemical investigations, EEG, ECG or abdominal ultrasound. In 2007, Wilson disease, Huntington's disease and acanthocytosis were not confirmed and differential diagnosis of diseases with tics was performed. The following were found: hyperbilirubinaemia (2.42 mg/dL), osmotic resistance of erythrocytes: initial haemolysis 0.48, complete haemolysis 0.40% NaCl, CPK = 177 U/L and innate spherocytosis. In 2009, acanthocytes were present (Fig. 1), as well as CPK 387 U/L, LDH = 244 U/L, total bilirubin level 25.2 μmol/L, direct bilirubin level 3.7 μmol/L were found. MRI scan showed mild atrophy of the left caudate nucleus and atrophy of the right hippocampus (Fig. 2).

The disorders presented in Tab. 1 were used in the differential diagnosis.

Psychological assessment

At first assessment, the Minnesota Multiphasic Personality Inventory (MMPI), Benton Visual Retention Test (BVRT), Bender Visual Motor Gestalt Test (BVMGT) and Raven Progressive Matrices were used.

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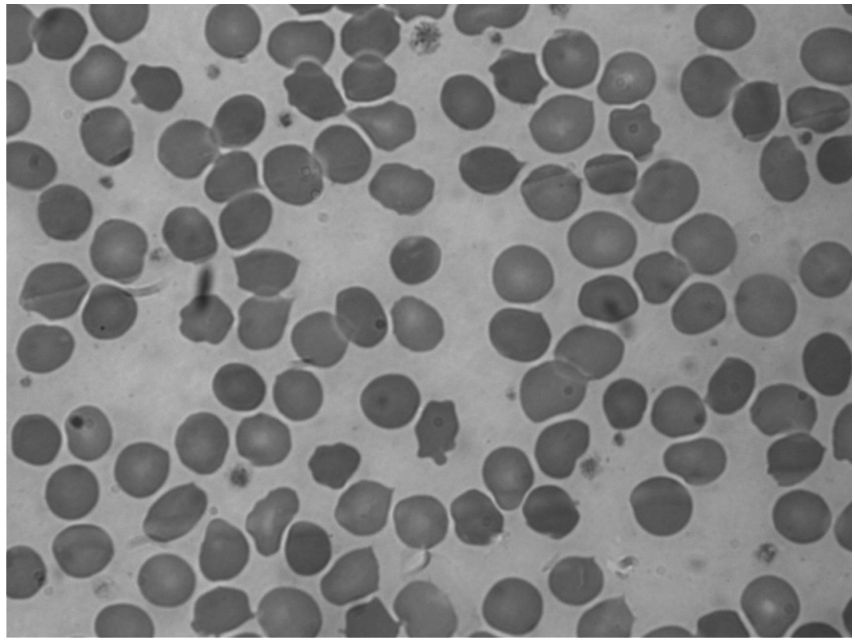

Fig. 1. Acanthocytes in the patient's peripheral blond smear

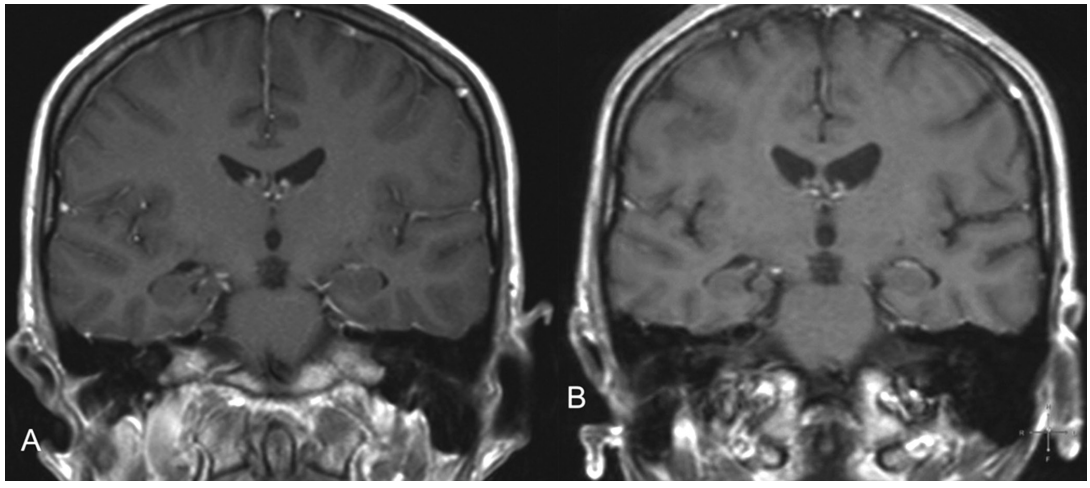

Fig. 2. Coronal view sections at the level of the third ventricle and hippocampal formation in the patient: A – 2007, B – 2011. MRI scans show progressive atrophy of the caudate nuclei (mainly of the left one), the right hippocampus and the whole brain

Emotional dysfunctions with dominating depressive-anxiety symptoms and passive – dependant personality traits were found. There were no cognitive or intellectual disturbances related to age. In MMPI profile, the scores of Gough Index (F-K = 13), Schizophrenia (66) and Social Introversion (65) Scales were elevated, which suggested exaggeration of symptoms or a way of "asking for help" due to the experienced discomfort.

In 2007, psychological testing was performed using the Wechsler Adult Intelligence Scale (WAIS-R), Auditory Verbal Learning Test (AVLT), Trail Making Test (TMT) and Verbal Fluency Test (VFT). The patient's global intellectual functioning was average, IQ = 86. Her verbal IQ was 85 and Performance IQ was 87, both of which were on average level. The scores obtained in the Picture Completion and Information were the highest while the scores in the Comprehension and Block Design were the lowest. The obtained results showed significantly reduced comprehension of social situations, visuospatial and motor skills. Also the readiness and stability of memory, the ability to differentiate less important details from more important ones were significantly higher than the patient's average. In the AVLT test she recalled 5, 6, 11, 12, 14 words, after disruption – 13 words and after 20 minutes – 14 words, which indicated correct auditory-verbal memory and learning. In verbal phonological (letter K) fluency trial, she uttered 9 words, and in semantic fluency trial (animals) – 19 words, which suggested reduced verbal fluency thinking. She scored 8 points in the TMT, which suggests attention and executive function disturbances.

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In 2009, a subsequent neuropsychological assessment was performed using the Mini-Mental State Examination (MMSE), Hospital Anxiety and Depression Scale (HADS), Clock Test and neuropsychological experiments. The patient was diagnosed with deficiencies of attention, immediate memory, learning and recognition, verbal fluency, ideational praxia, calculation abilities as well as depressive and anxiety disorders. On neuropsychological examination, difficulties in adjusting behaviour to environmental conditions and flexible correction of wrong responses were found. Moreover, depressed mood and dysarthric speech were observed (MMSE – 25, HADS: A – 12, D – 6).

Comparison of neuropsychological data indicates gradual increase in dysfunction, mainly of executive functions, auditory-verbal memory, visuo-spatial abilities, social comprehension and adjusting behaviour to the environment. The patient's symptoms were similar to those fronto-subcortical described by other researchers (Kartsounis and Hardie, 1996). Gradual worsening of cognitive, emotional and behavioural functions may result from dementia due to subcortical atrophy, particularly in the caudate nucleus and the hippocampus.

CONCLUSIONS

The patient was diagnosed with neurological, psychiatric and neuropsychological disorders. The neurological disorders included gradually increasing involuntary movements of the face and tongue, upper limb chorea, dysarthric speech, slight upper limb deep reflexes, vivid knee jerks, tonic-clonic seizures and no Achilles reflexes. Psychiatrically, she was depressed and presented with obsessive thinking. Neuropsychological assessment revealed increasing dysfunctions of attention, immediate memory, learning, verbal fluency, praxia, calculia and difficulties in adjusting behaviour to environmental conditions and in flexible correction of wrong responses.

Our single case study can be a valuable source of knowledge on neuropsychiatric and neuropsychological symptoms since the prevalence of the disorder is very low and it is not possible to conduct investigations in a large group of patients.

We suggest that neuropsychiatric and neuropsychological dysfunctions should be considered in the differential diagnosis to ensure proper diagnosis and management, especially when differentiating disorders in patients with neuropsychiatric symptoms, chorea, or in the case of late (in adulthood) onset of Tourette's syndrome.

Conflict of interest

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

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References

Allen FH Jr, Krabbe SM, Corcoran PA: A new phenotype (McLeod) in the Kell blood-group system. Vox Sang 1961; 6: 555–560.

Brecher G, Bessis M: Present status of spiculed red cells and their relationship to the discocyte-echinocyte transformation: a critical review. Blood 1972; 40: 333–344.

Critchley EM, Clark DB, Wikler A: Acanthocytosis and neurological disorder without betalipoproteinemia. Arch Neurol 1968; 18: 134–140.

Danek A, Rubio JP, Rampoldi L et al.: McLeod neuroacanthocytosis: genotype and phenotype. Ann Neurol 2001; 50: 755–764.

Dulski J, Sołtan W, Schinwelski M et al.: Clinical variability of neuroacanthocytosis syndromes – a series of six patients with long follow-up. Clin Neurol Neurosurg 2016; 147: 78–83.

Estévez-Fraga C, López-Sendón Moreno JL, Martínez-Castrillo JC; Spanish Collaborative Neuroacanthocytosis Group: Phenomenology and disease progression of chorea-acanthocytosis patients in Spain. Parkinsonism Relat Disord 2018; 49: 17–21.

Hayflick SJ, Westaway SK, Levinson B et al.: Genetic, clinical, and radiographic delineation of Hallervorden–Spatz syndrome. N Engl J Med 2003; 348: 33–40.

Hewer E, Danek A, Schoser BG et al.: McLeod myopathy revisited: more neurogenic and less benign. Brain 2007; 130: 3285–3296.

Ho M, Chelly J, Carter N et al.: Isolation of the gene for McLeod syndrome that encodes a novel membrane transport protein. Cell 1994; 77: 869–880.

Jastrzębski K, Pawełczyk A, Klimek A: Choreoakantocytoza – przypadek kliniczny. Aktualn Neurol 2010; 10: 118–122.

Jung HH, Danek A, Frey BM: McLeod syndrome: a neurohaematological disorder. Vox Sang 2007; 93: 112–121.

Jung HS, Danek A, Walker RH: Neuroacanthocytosis. Adv Clin Neurosci Rehabil 2009; 9: 16–20.

Jung HH, Danek A, Walker RH et al.: McLeod neuroacanthocytosis syndrome. In: Adam MP, Ardinger HH, Pagon RA et al. (eds.): GeneReviews® [Internet]. University of Washington, Seattle 1993–2019. 2004 Dec 3 [updated 2019 May 23].

Jung HH, Hergersberg M, Kneifel S et al.: McLeod syndrome: a novel mutation, predominant psychiatric manifestations, and distinct striatal imaging findings. Ann Neurol 2001; 49: 384–392.

Kartsounis LD, Hardie RJ: The pattern of cognitive impairments in neuroacanthocytosis. A frontosubcortical dementia. Arch Neurol 1996; 53: 77–80.

Komiya H, Takasu M, Hashiguchi S et al.: A case of McLeod syndrome with a novel *XK* missense mutation. Mov Disord Clin Pract 2018; 5: 333–336.

Levine IM: A hereditary neurological disease with acanthocytosis. Neurology 1964; 14: 272.

Liu Y, Liu ZY, Wan XH et al.: Progress in the diagnosis and management of chorea-acanthocytosis. Chin Med Sci J 2018; 33: 53–59.

Margolis RL, O'Hearn E, Rosenblatt A et al.: A disorder similar to Huntington's disease is associated with a novel CAG repeat expansion. Ann Neurol 2001; 50: 373–380.

Min KHC, Pedley TA, Rowland LP: Neurologic syndromes with acanthocytes. In: Rowland LP, Pedley TA (eds.): Merritt's Neurology. 12th ed., Lippincott Williams & Wilkins, Philadelphia 2010: 665–668.

Oechslin E, Kaup D, Jenni R et al.: Cardiac abnormalities in McLeod syndrome. Int J Cardiol 2009; 132: 130–132.

Peikert K, Danek A, Hermann A: Current state of knowledge in Chorea-Acanthocytosis as core Neuroacanthocytosis syndrome. Eur J Med Genet 2018; 61: 699–705.

Rampoldi L, Dobson-Stone C, Rubio JP et al.: A conserved sorting-associated protein is mutant in chorea-acanthocytosis. Nat Genet 2001; 28: 119–120.

Roulis E, Hyland C, Flower R et al.: Molecular basis and clinical overview of McLeod syndrome compared with other neuroacanthocytosis syndromes: a review. JAMA Neurol 2018; 75: 1554–1562.

Schneider C, Danek A, Hostmann A et al.: [Early diagnosis of chorea-acanthocytosis: orofacial dyskinesia, epileptic seizures, and hyperCKemia]. Fortschr Neurol Psychiatr 2017; 85: 270–273.

Shannon KM: Movement disorders. In: Bradley WG, Daroff RB, Fenichel GM et al. (eds.): Neurology in Clinical Practice. 4th ed., Butterworth and Heinemann, Philadelphia 2004: 2125–2168.

Stanfield GM, Horvitz HR: The *ced-8* gene controls the timing of programmed cell deaths in *C. elegans*. Mol Cell 2000; 5: 423–433.

Storch A, Kornhass M, Schwarz J: Testing for acanthocytosis. A prospective reader-blinded study in movement disorder patients. J Neurol 2005; 252: 84–90.

Velayos Baeza A, Dobson-Stone C, Rampoldi L et al.: Chorea-acanthocytosis. In: Adam MP, Ardinger HH, Pagon RA et al. (eds.): GeneReviews® [Internet]. University of Washington, Seattle 1993–2019. 2002 Jun 14 [updated 2019 Apr 18].

Walker RH, Jankovic J, O'Hearn E et al.: Phenotypic features of Huntington's disease-like 2. Mov Disord 2003; 18: 1527–1530.

Walker RH, Jung HH, Dobson-Stone C et al.: Neurologic phenotypes associated with acanthocytosis. Neurology 2007; 68: 92–98.

Walker RH, Miranda M, Jung HH et al.: Life expectancy and mortality in chorea-acanthocytosis and McLeod syndrome. Parkinsonism Relat Disord 2019; 60: 158–161.

Zeman A, Shenton G: Neuroacanthocytosis. Pract Neurol 2004; 4: 298–301.

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