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NON-ALCOHOLIC WERNICKE'S ENCEPHALOPATHY IN A KIDNEY TRANSPLANT RECIPIENT

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Background. Non-alcoholic Wernicke's encephalopathy occurs in various somatic conditions with thiamine deficiency, excessive excretion of thiamine, or impaired thiamine metabolism. Very few cases of this pathology have been described in chronic kidney disease (CKD). We present a unique case of non-alcoholic Wernicke's encephalopathy in a patient with a kidney transplant is presented. **Past medical history.** The patient underwent kidney transplantation in 2008. Outpatient follow-up by a nephrologist was irregular. Renal graft function remained relatively stable: blood creatinine 200–240 μmol/L, estimated glomerular filtration rate 40–30 mL/min, tacrolimus plasma concentrations tended to increase (5.7–7.6–8.4–10.4 ng/mL); repeated graft biopsy (in 2015 and in 2017) determined the chronic toxicity of calcineurin inhibitors. The patient's condition worsened in late January 2020: body temperature increased to 38°C, nausea, vomiting, loose, watery stools for up to 5 times per day, 8 kg weight loss, decreased diuresis. A few days later, double vision, shaky gait and then immobility appeared. Biochemical examination results: potassium 3.8 mmol/L, sodium 139 mmol/L, alpha-amylase 159 units/L (norm 0–100 units/L), creatinine 242 mmol/L, urea 13.2 mmol/L; ultrasound signs of pancreatitis. Magnetic resonance imaging (MRI) of the brain: bilateral diffuse lesions of the midbrain, thalamus, and cerebellum. Based on the clinical picture and on brain MRI results, Wernicke's encephalopathy was diagnosed. Parenteral administration of thiamine had a good effect. **Conclusion.** Possible mechanisms of the development of Wernicke's encephalopathy in a patient were discussed. Vigilance is required regarding this disease when metabolic disorders occur in patients with CKD.

Keywords: Wernicke's encephalopathy, kidney transplantation, pancreatitis, thiamine.

Wernicke's encephalopathy is a rare severe degenerative brain damage first described by German psychiatrist Carl Wernicke in 1881 as acute superior haemorrhagic polio-encephalitis in two men suffering from alcoholism and a woman with pyloric stenosis [1]. Thiamine (vitamin B1) deficiency underlies the disease, but this association became known much later than the first observations described by C. Wernick in the middle of the last century [2]. Thiamine is a water-soluble vitamin that is not synthesized in the body; its daily requirement depends on carbohydrate intake – 1–2 mg for a healthy person. Total thiamine reserves in the body are relatively small – 30–50 mg – and are completely depleted after 4–6 weeks in the absence of thiamine intake. Thiamine is required by cell membranes to maintain osmotic gradient, and is involved in glucose metabolism and neurotransmitter synthesis. Vitamin deficiency can be twofold: exogenous (due to insufficient intake from food) and endogenous (due to impaired absorption of the vitamin in the gastrointestinal tract or its increased excretion). Another possible mechanism for the onset of Wernicke's encephalopathy is the inhibition of thiamine conversion into thiamine pyrophosphate – the active part of alpha-ketoglutarate dehydrogenase, pyruvate dehydrogenase and transketolase – enzymes that ensure normal metabolism of nervous tissue. Therefore, in case of thiamine reduction in the body, the most pronounced changes occur in the brain, where the activity of oxidative metabolism is very high: lack of energy leads to reduced glucose utilization by neurons and damage in their mitochondria [2].

The exact prevalence of the disease is unknown; diagnosis is often established only at autopsy. In general, the incidence of Wernicke's encephalopathy is estimated at 0.4–2.8%, with a lower incidence of 0.04–0.13% for that of non-alcoholic origin [3]. The most common cause of Wernicke's encephalopathy is alcoholism. Non-alcoholic Wernicke encephalopathy occurs in many clinical situations, most often associated with malnutrition or acute metabolic stress. In particular, thiamine deficiency can be experienced by patients suffering from cancer, sepsis, those undergoing surgical procedures, etc. [3, 4]. Despite the indicated rarity of this condition, only in the last few years a large number of clinical observations of Wernicke's encephalopathy in patients not abusing alcohol have been described: with gastrointestinal disorders of various origins (surgery, cancer, pregnancy, etc.), fasting or strict dietary restrictions (strict adherence to fasting), malnutrition, anorexia nervosa, brain injury, encephalitis with lesions of the basal nuclei and temporal lobes, and carbon monoxide poisoning [5–13]. It is of interest to observe Wernicke's encephalopathy in patients

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who underwent liver, bone marrow, hematopoietic stem cell transplantation [14–16]. At the same time, according to PubMed search engine results, Wernicke's encephalopathy is rarely described in chronic kidney disease (CKD), although this disease is characterized by a wide variety of metabolic disorders. We have encountered only a small series of observations in patients receiving dialysis therapy [17–21]. We present a unique case of non-alcoholic Wernicke encephalopathy, which developed against the background of metabolic disorders in a patient with a kidney transplant. This is the first report of its kind; we have not found any such description in any other available published report.

***Patient N.**, born in 1988, from a distant Moscow suburb, has been observed at the kidney transplantation ward of Vladimirsky Moscow Regional Research Clinical Institute in Moscow since 2007. The patient considers himself sick since 2006, when his blood pressure increased to 250/160 mm Hg and he developed peripheral edema (lower extremities). Examination revealed increased blood creatinine levels to 300 μmoL/l (estimated glomerular filtration rate (eGFR) 25 mL/min). Chronic glomerulonephritis was diagnosed (without histological confirmation), stage 4 CKD, nephroprotective and symptomatic therapy was administered. In August 2007, due to the development of end-stage chronic renal failure, long-term hemodialysis therapy was initiated. A year later (November 6, 2008), cadaveric kidney transplantation was performed, immunosuppressive therapy was conducted according to the standard protocol: basiliximab 40 mg, metipred 1000 mg, prednisolone 30 mg/day, tacrolimus at 0.2 mg/kg/day starting dose until the target concentration was reached and mycophenolic acid 1440 mg/day. Graft function was delayed; 3 hemodialysis sessions were performed. Diuresis was restored in a week with a gradual decrease in azotemia levels (Table 1). Ultrasound examination of the kidney transplant was unremarkable. The patient was discharged a month later in a satisfactory condition, with stable graft function.*

The patient was readmitted 1.5 months later due to deterioration of the condition: loss of appetite, diffuse abdominal pain, vomiting, persistent diarrhea, low-grade fever. On admission, the patient's condition was moderate, body temperature 37.6 °C, dry skin, and visible mucous membrane. Respiratory rate was 22/min, with no peculiarities on lung auscultation. BP 85/55 mm Hg, pulse 120/min, low-filled. The abdomen was moderately swollen, painful on palpation in the epigastric region. There were no acute abdominal symptoms. Renal graft in the left iliac region, elastic, painless. Diuresis 1000 mL/day. Complete blood count: hemoglobin 10^9 g/L, white blood cells 1.3 × 10^9/L, neutrophils 0.5 × 10^9/L, platelets 95 × 10^9/L. Hematologist's conclusion: grade 4 neutropenia. Blood electrolytes: sodium 137 mmol/L, potassium 3.4 mmol/L, calcium, phosphorus within normal range. Total bilirubin, liver enzymes, alkaline phosphatase, glucose, and blood lipids were within the reference values. Serum amylase level was 257 U/L (normal 0–100), blood creatinine and urea were respectively 600 μmol/L, and 34 mmol/L. Bacteriological examination of stool: Candida pp 10^6, E. coli 10^9, Ps. vulgaris 10^6 CFU/ml. The test result for cytomegalovirus, Epstein–Barr virus, hepatitis was negative. Ultrasound examination of the renal graft was unremarkable, abdominal organs – signs of acute pancreatitis. The patient was examined by a gastroenterologist with the following diagnosis: acute pancreatitis, intestinal dysbiosis. In general, the patient's clinical and laboratory symptoms were consistent with acute pancreatitis, acute graft injury, and grade 4 neutropenia. The therapy administered included intravenous infusion of saline, antibiotics, including antifungal and antiviral, a proton pump inhibitor, antispasmodic drugs, and a prebiotic. Mycophenolic acid was canceled, granulocyte colony-stimulating factor (filgrastim) was prescribed, methylprednisolone in a total dose of 1000 mg was administered. A few days later, the patient's condition improved: body temperature returned to normal, vomiting stopped, stool normalized, abdominal pain regressed, blood pressure 115/85 mm Hg, daily urine output increased to 2.5 L, blood creatinine and urea levels decreased to 330 μmol/L and 26 mmol/L, respectively, with a further decrease, white blood cells 5.0 × 10^9/L, platelets 167 × 10^9/L. A week later, renal graft biopsy was performed with the following conclusion: the histological picture

Table 1

Results of laboratory examination of patient N. in the early postoperative period after kidney transplantation

Indicator	Kidney transplantation, Nov. 6, 2008		
	Nov. 13, 2008	Nov. 21, 2008	Dec. 2, 2008
Diuresis, mL/day	2000	3600	3400
Creatinine, μmol/L	790	390	180
Urea, mmol/L	27	30	20
Hemoglobin, g/L	100	96	101
Bilirubin, μmol/L	4.0	7.8	9.7
AST, units/L	21	12	10
ALT, units/L	40	18	9
Alkaline phosphatase, u/L	60	61	70
Albumin, g/L	43	40	36
Cholesterol, mmol/L	3.1	3.7	3.3
Uric acid, μmol/L	327	595	443
Glucose, mmol/L	4.0	5.2	4.9
Calcium, mmol/L	2.2	2.1	2.1
Phosphorus, mmol/L	2.8	2.1	1.1
Daily proteinuria, g	2.6	0.87	0.43
Tacrolimus serum concentration, ng/mL	7.2	8.6	10.3

is consistent with acute tubular necrosis of the donor organ. A month later, the patient was discharged in satisfactory condition with normal peripheral blood and biochemical parameters, with satisfactory graft function (blood creatinine 180 μmol/L, blood urea 9.3 mmol/L).

There was outpatient follow-up at the consultative and diagnostic center of Vladimirsky Moscow Regional Research Clinical Institute 1–3 times a year (Table 2). Tacrolimus dose was adjusted taking into account its serum concentration, which tended to increase; graft function remained relatively stable. In the fall of 2014, the patient independently stopped taking prednisolone, after which he developed peripheral edema (lower extremities), his blood pressure increased to 180/110 mm Hg; During examination, daily proteinuria was 2 g. In October 2015, a repeated biopsy of the renal graft was performed with the following conclusion: chronic graft nephropathy stage 1, chronic calcineurin inhibitor toxicity. The patient resumed taking prednisolone, tacrolimus dose was adjusted, and an angiotensin-converting enzyme inhibitor was prescribed. His condition stabilized, peripheral edema disappeared, blood pressure returned to normal 125–130/80 mmHg, proteinuria decreased to 1.2 g/day.

In July 2017, with increasing proteinuria, a third nephrobiopsy was performed with the following conclusion: chronic calcineurin inhibitor nephrotoxicity with diffuse global nephrosclerosis, chronic graft nephropathy stage 2.

Sudden deterioration at the end of January of the current year: body temperature increased to 38 °C, nausea, vomiting, loose, watery stools up to 5 times a day, up to 8 kg weight loss, decreased urine output. A few days later, double vision, shaky gait, then immobility appeared; the patient was admitted to an infectious diseases clinic at his place of residence. No evidence of acute infectious pathology was obtained. Complete blood count: hemoglobin 121 g/L, white blood cells 6.6 × 10^9/L, platelets 324 × 10^9/L; biochemical blood test: potassium 3.8 mmol/L, sodium 139 mmol/L, liver enzymes within normal values, creatinine 242 mmol/L, urea 13.2 mmol/L. Ultrasound examination of the abdominal organs and kidney transplant was unremarkable, except for the pancreas, which showed ultrasound signs of pancreatitis: the gland was enlarged, with indistinct contours, increased echogenicity and heterogeneous (blurred) structure. An increase in neurological symptoms was recorded, brain MRI was performed with the following conclusion: central pontine myelinolysis. The condition was regarded as a secondary autoimmune process, methylprednisolone pulse therapy methylprednisolone in a total dose of 3000 mg was administered. Simultaneously, symptomatic, neuroprotective, antibacterial therapy was administered. However, the patient's condition continued to deteriorate: he stopped swallowing solid food, hyperkinetic disorders appeared. The patient was transferred to the intensive care unit of Vladimirsky Moscow Regional Research Clinical Institute.

On admission, his condition was serious. He was conscious with a normosthenic physique. Reduced nutrition. His skin and mucous membranes were moist, pale pink. Vesicular breathing, no wheezing, respiratory rate 17 per minute. Muffled heart sounds, rhythmic. BP 150/80 mm Hg. Heart rate 90 beats/min, satisfactory filling. Moist tongue, coated with white plaque. Soft abdomen, painless on palpation. The liver was not enlarged. Peristalsis was audible. The graft was palpable in the left iliac region, elastic, and painless. Unassisted urination. Diuresis 1200 mL/day. Laboratory results are presented in Table 3.

Neurological status. The patient was conscious, on a Glasgow Coma Scale score of 15. Productive contact was difficult due to speech disorders. Speech with gross dysarthria. Nasal tone of voice (nasolalia). No meningeal signs. Correctly oriented, lethargic, apathetic, drowsy. Obeys simple commands. Emotionally labile, quickly exhausted. Hearing was not impaired. D = S eye slits, bilateral partial ptosis. Did not follow the hammerhead.

Table 2

Results of laboratory examination of patient N. at the outpatient follow-up stage

Parameter	Date of examination at the Consultative and Diagnostic Center, Vladimirsky Moscow Regional Research Clinical Institute										
	Aug. 27, 2009	Aug. 2, 2010	May 19, 2011	Nov. 29, 2012	Nov. 28, 2013	Nov. 20, 2014	Oct. 29, 2015	Nov. 24, 2016	July 24, 2017	Nov. 28, 2018	Aug. 5, 2019
Diuresis, mL/day	1700	–	1800	1900	1800	1800	2100	2300	2200	–	1800
Blood creatinine, μmol/L	210	220	190	180	240	210	180	206	210	270	240
eGFR, mL/min	38	36	42	44	31	37	43	36	35	26	30
Blood urea, mmol/L	9.2	11.1	9.7	10.5	11.6	12.1	12.4	10.8	9.2	18.2	17.8
Proteinuria, g/day	1.6	–	0.6	1.2	0.5	1.8	1.2	0.6	1.1	–	0.4
Tacrolimus serum concentration, ng/mL	6.4	6.5	8.4	4.9	5.4	6.6	7.6	8.5	7.3	7.6	6.5

Rounded pupils, D < S. Photoreactions: direct and concomitant, OD = OS = lively. Face was symmetrical, tongue along the midline. Pharyngeal reflex depressed, choking when swallowing. Raising the shoulders and turning the head were not impaired. Motor functions: amount of active and passive movement was not limited. Strength of arm muscles D = S = 5 points, legs D = S = 5 points. Tone in the extremities is physiological. Tendon and periosteal reflexes: from the hands D = S, lowered; knee D = S, lowered; Achilles D = S, lowered. No pathological foot marks. Coordination of movements: fingers – a nasal test was performed with pronounced coarse tremor and past-pointing, more on the left. No sensitive impairments.

A differential diagnosis between central pontine myelinolysis and Wernicke's encephalopathy was made. The absence of hyponatremia and hypoosmolarity in the patient throughout the disease, as well as the effect of methylprednisolone pulse therapy (3000 mg in total) made the diagnosis of central pontine myelinolysis and the autoimmune nature of this condition doubtful. Repeated brain MRI was performed: no volumetric masses were detected in the brain substance. In the midbrain, in the dorsal thalamus, in the superior cerebellar peduncle and paraventricularly around the fourth ventricle, as well as in the vermis and the anterior lobe of both cerebellar hemispheres, almost symmetrically, a pathological MR signal area – hyperintense MR signal on T2-weighted images, isointensive – on T1-weighted images, without volumetric effects on adjacent brain structures – was visualized. Diffusion-weighted imaging showed diffusion restriction from 2 symmetrically located foci in the midbrain due to edema. In the white matter of the cerebral hemispheres, multiple different-sized foci of the altered MR signal with fairly clear contours, up to 8 mm in maximum dimension, with a tendency for fusion of 2 lateral ventricles in the leuoaraiosis zone were detected. There was no dislocation of midline structures. All cerebrospinal fluid (CSF) pathways – basal cisterns, cerebral ventricles and external subarachnoid space along the cerebral hemispheres and cerebellum – were not dilated. The pituitary gland was not enlarged. The craniovertebral junction is correctly formed, the cerebellar tonsils were at the level of the foramen magnum plane. The paranasal sinuses were airy. The orbits were without pathological changes. Conclusion: MRI signs of Wernicke's encephalopathy: bilateral diffuse lesion of the midbrain, thalamus and cerebellum without volumetric effect on adjacent brain structures; focal white matter lesion is probably a manifestation of metabolic encephalopathy (Fig.).

Based on clinical symptoms, the presence of oculomotor disorders, ataxia, changes in mental status and characteristic MRI signs of brain injury, as well as given the onset of the disease, corresponding to a severe exacerbation of chronic pancreatitis, the patient was diagnosed with neurological Wernicke's encephalopathy. Treatment was prescribed according to the guidelines of the European Federation of Neurological Societies [22]: intramuscular thiamine hydrochloride 300 mg/day (10 days), 200 mg/day (10 days), 100 mg/day for 1 month, then oral benfotiamine 150 mg/day for 1 month; thioctic acid 600 mg/day, intravenous drip, followed by a switch to oral administration for 1 month; intramuscular pyridoxine hydrochloride 100 mg/day (10 days), intramuscular cyanocobalamin 1000 mcg/day (10 days).

The patient's condition improved against the background of the therapy, he became more active, his vision began to recover, and his speech improved. To continue treatment, the patient was transferred to a neurological hospital at the place of his residence. Six months later, he was examined at the consultative and diagnostic center of Vladimirsky Moscow Regional Research Clinical Institute with the following conclusions: satisfactory condition, neurological status without pathological changes, graft function remained reduced and stable: blood urea 14.1 mmol/L, blood creatinine 239 mmol/L, eGFR 30 mL/min, daily proteinuria 1.3 g, tacrolimus plasma concentration 6.6 ng/mL.

Table 3

Results of laboratory examination of patient N. at the last hospitalization

Indicator	At admission	At discharge
Content in the blood		
Creatinine, μmol/L	241	205
eGFR, ml/min	30	37
Urea, mmol/L	23.7	22.3
Tacrolimus, ng/ml	8.6	4.9
Alpha-amylase (norm 0–100 U/L)	153	69
Hemoglobin, g/L	119	126
Bilirubin, μmol/L	15.1	9.8
AST, units/L	22	17
ALT, units/L	12	12
Alkaline phosphatase, u/L	177 (norm 0–258 units/L)	68 (norm 30–120 units/L)
Albumin, g/L	41	45
Cholesterol, mmol/L	4.0	4.1
Osmolarity, mosmol/L	291	282
Sodium, mmol/L	141	138
Potassium, mmol/L	3.3	4.3
Ionized calcium, mmol/L	1.14	1.17
Phosphorus, mmol/L	1.62	1.2
Procalcitonin, ng/mL (norm 0–0.1)	0.2	–
Diuresis, mL/day	1200	2300
Daily proteinuria, g	1.5	1.1

DISCUSSION

So, our patient was diagnosed with Wernicke's encephalopathy, a severe brain injury caused by thiamine deficiency, in the long-term (after 11 years) post-transplant period. It is known that the latter occurs not only with chronic alcoholism, which our patient does not suffer from, but also with a number of other somatic diseases. In this case, the leading risk factor for Wernicke's encephalopathy was most likely acute exacerbation of chronic pancreatitis, as indicated by his increased serum amylase levels and pancreas ultrasound examination findings. Anorexia, repeated vomiting, and diarrhea caused by pancreatitis caused insufficient intake, excessive excretion of thiamine and its depletion in the body. There has been a reported case of non-alcoholic Wernicke encephalopathy in pancreatitis complicated by severe metabolic disorders [23]. In turn, the appearance of pancreatitis and gastroenterological disorders in our patient could be associated with tacrolimus toxicity. It is reported that up to 75% of patients taking this calcineurin inhibitor have some type of gastrointestinal issues [24]. In our patient, chronic calcineurin inhibitor toxicity had a long history and was confirmed by repeat renal graft biopsy. The patient's low compliance, possibly due to his youth and/or a far-away place of residence, made his dynamic examination and follow-up by a nephrologist irregular. Another mechanism of thiamine deficiency in our patient can be assumed to be a disorder in its phosphorylation,

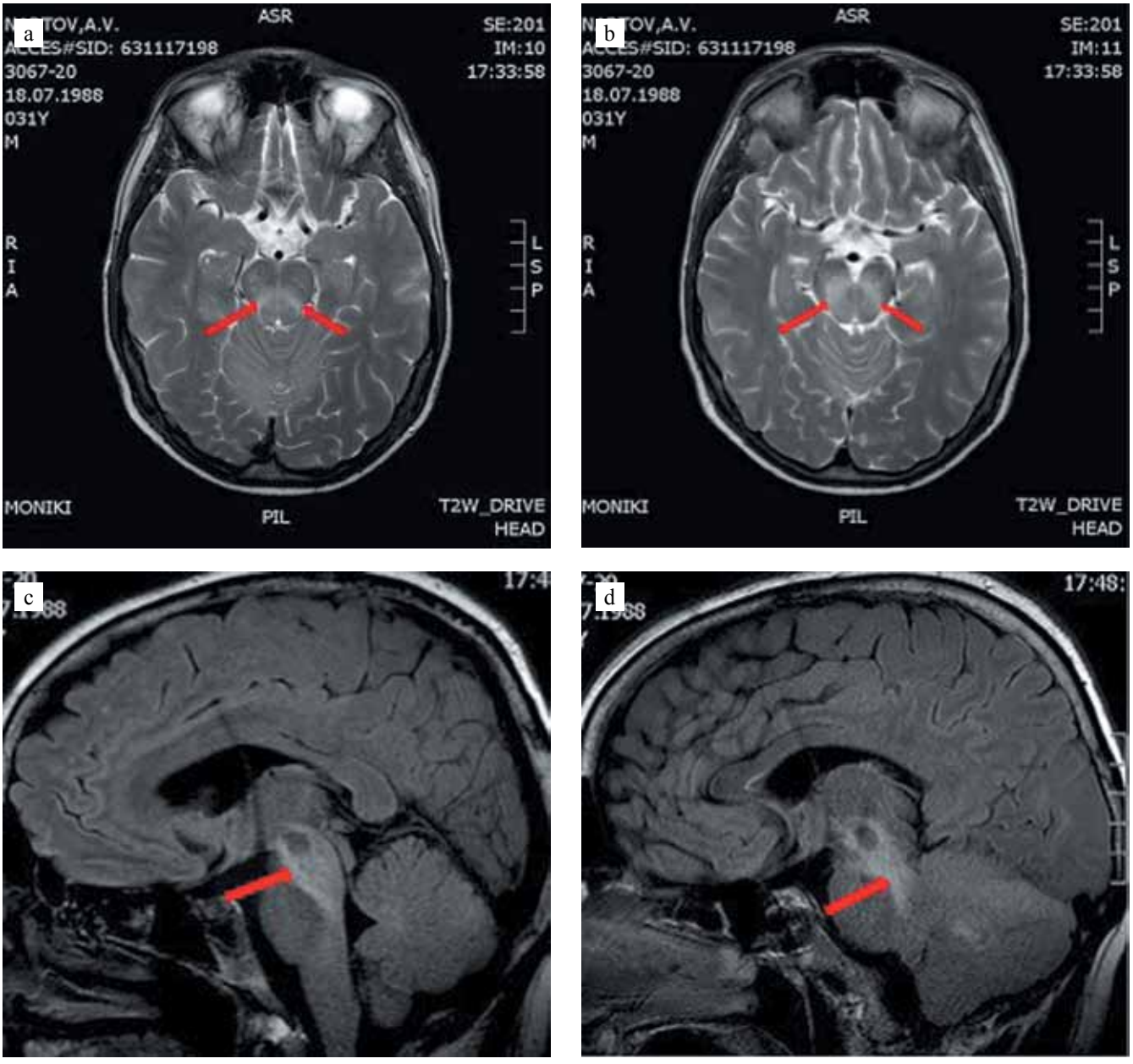

Fig. Non-contrast-enhanced magnetic resonance imaging of the brain of patient N.: a, b. T2-weighted (axial) images of the brain; c, d. diffusely weighted (sagittal) images of the brain. Symmetrical enhancement of the MR signal from the midbrain and thalamus (shown by arrows)

which occurs with the participation of magnesium [25, 26]. Decreased serum magnesium levels associated with inhibition of its tubular reabsorption under the influence of calcineurin inhibitors is more common in the early postoperative period but is also possible in the long term [27]. However, measuring the serum magnesium levels is not a routine biochemical test and has not been performed in this case.

Wernicke's encephalopathy in non-alcoholic patients has mainly complex clinical manifestations and atypical development of the disease [3, 5, 10, 11]. Our patient turned out to be an exception in this respect. In him, Wernicke encephalopathy manifested itself by the classical triad described by the author: oculomotor disorders, ataxia, and mental disorders, although this triad occurs in a third or half of patients [1, 3, 11]. It was the classical clinical symptoms, as well as the absence of hyponatremia episodes during the course of the disease, that served as the basis for diagnosis of Wernicke's encephalopathy and exclusion of central pontine myelinolysis. The diagnosis is usually verified by neuroimaging – brain MRI reveals a symmetrical medial thalamic lesion, which occurred in the patient we observed [5, 11]. Finally, the rapid response to parenteral thiamine administration provided additional supporting evidence in favor of Wernicke's encephalopathy.

If the timeliness of the diagnosis of Wernicke's encephalopathy is based on clinicians' awareness, alertness and familiarity with the predisposing factors and clinical symptoms of the disease, its prognosis depends on the earliest possible initiation of pathogenetic therapy, i.e. adequate thiamine administration. Delaying treatment or not initiating it at all can lead to Korsakoff's psychosis or even death [3, 5]. An important point of this observation was the correct diagnosis of Wernicke's encephalopathy and the immediate administration of thiamine, which led to a good outcome – complete disappearance of neurological symptoms in the patient.

CONCLUSION

This clinical case is the first description of Wernicke's encephalopathy in a kidney recipient. It indicates the complexity of diagnosis and the difficulty of differential diagnosis of this condition with central pontine myelinolysis, as well as the curability of this disease with the right management tactics. This case highlights the importance of being vigilant for Wernicke's encephalopathy in situations involving significant metabolic disorders that are common in CKD. Timely diagnosis and proper treatment will improve the prognosis.

The authors declare no conflict of interest.

ЛИТЕРАТУРА/REFERENCES

1. *Wernicke C.* Die akute hämorrhagische polioencephalitis superior. Fischer Verlag, Kassel. Lehrbuch der Gehirnkrankheiten für Ärzte und Studierende 1881; II: 229–242.
2. *Campbell ACP, Russell WR*. Wernicke's encephalopathy: the clinical features and their probable relationship to vitamin B deficiency. *Q J Med*. 1941; 10: 41–64.
3. *Ota Y, Capizzano AA, Moritani T, Naganawa S, Kurokawa R, Srinivasan A*. Comprehensive review of Wernicke encephalopathy: Pathophysiology, clinical symptoms and imaging findings. *Jpn J Radiol*. 2020 Sep; 38 (9): 809–820. doi: 10.1007/s11604-020-00989-3.
4. *Chamorro AJ, Rosón-Hernández B, Medina-García J-A, Muga-Bustamante R, Fernández-Solá J, Martín-González MC et al*. Differences between alcoholic and nonalcoholic patients with Wernicke encephalopathy: A multicenter observational study. *Mayo Clin Proc*. 2017; 92 (6): 899–907. doi: 10.1016/j.mayocp.2017.02.019.
5. *Semple D, Smyth R*. Oxford handbook of psychiatry. Oxford: Oxford University Press; 2013. 1057 p. doi: 10.1093/med/9780199693887.001.0001
6. *Doğan İG, Altiokka GU, Türker F, Saka B, Bilgiç B, Orhan EK*. Wernicke's encephalopathy due to non-alcoholic gastrointestinal tract disease. *Noro Psikiyatr Ars*. 2018; 55 (4): 307–314. doi: 10.29399/npa.23010.
7. *Mantero V, Rifino N, Costantino G, Farina A, Pozzetti U, Sciacco M et al*. Non-alcoholic Beriberi, Wernicke encephalopathy and long-term eating disorder: Case report and a mini-review. *Eat Weight Disord*. 2021 Mar; 26 (2): 729–732. doi: 10.1007/s40519-020-00880-0. Epub 2020 Mar 4.
8. *Oudman E, Wijnia JW, Oey M, van Dam M, Painter RC, Postma A*. Wernicke's encephalopathy in hyperemesis gravidarum: A systematic review. *Eur J Obstet Gynecol Reprod Biol*. 2019; 236: 84–93. doi: 10.1016/j.ejogrb.2019.03.006.
9. *Oudman E, Wijnia JW, Oey MJ, van Dam MJ, Postma A*. Preventing Wernicke's encephalopathy in anorexia nervosa: A systematic review. *Psychiatry Clin Neurosci*. 2018; 72 (10): 774–779. doi: 10.1111/pcn.12735.
10. *Yin H, Xu Q, Cao Y, Qi Y, Yu T, Lu W*. Nonalcoholic Wernicke's encephalopathy: A retrospective study of 17 Cases. *J Int Med Res*. 2019; 47 (10): 4886–4894. doi: 10.1177/0300060519870951.
11. *Liu Y-L, Xiao W-M, Liang M-Q, Wu Z-Q, Wang Y-Z, Qu J-F, Chen Y-K*. Clinical characteristics and magnetic resonance imaging findings in nine patients with nonalcoholic Wernicke's encephalopathy: A retrospective study. *Neuropsychiatr Dis Treat*. 2019; 15: 2433–2441. doi: 10.2147/NDT.S217237.
12. *Alizadeh L, Mostafavi Z, Jahanshahi A, Khani M, Nouri-Vaskeh M*. Wernicke encephalopathy following gastrojejunostomy: A case report and review of the literature. *Turk J Emerg Med*. 2019; 19 (4): 154–156. doi: 10.1016/j.tjem.2019.08.001
13. *Shah IA, Asimi RP, Kawoos Y, Wani M, Saleem T, Baba WN*. Nonalcoholic Wernicke's encephalopathy: A retrospective study from a tertiary care center in Northern India. *J Neurosci Rural Pract*. 2017; 8 (3): 401–406. doi: 10.4103/jnrp.jnrp_14_17.
14. *Xie B, Si Z-Z, Tang W-T, Qi H-Z, Li T*. Wernicke encephalopathy in a patient after liver transplantation: A Case re-

port. *World J Gastroenterol*. 2017; 23 (47): 8432–8436. doi: 10.3748/wjg.v23.i47.8432.
15. *Di Giuliano F, Picchi E, Scaggiante J, Ferrante P, Misciasci T, Da Ros V et al*. Posterior reversible encephalopathy syndrome and Wernicke encephalopathy in patient with acute graft-versus-host disease. *Radiol Case Rep*. 2019; 14 (8): 971–976. doi: 10.1016/j.radcr.2019.05.024.
16. *Xue S, Yuan L, Cheng H-Y, Yin Y-M, Gu J-Y, Zhang W-J, Wang J-B*. Four cases of Wernicke's encephalopathy following hematopoietic stem cell transplantation. *Zhongguo Shi Yan Xue Ye Xue Za Zhi*. 2018; 26 (3): 880–885. doi: 10.7534/j.issn.1009-2137.2018.03.042.
17. *Chen G, Chen LM, Li XM*. The 473rd case: Renal failure, abdominal pain, and mental abnormality. *Zhonghua Nei Ke Za Zhi*. 2020; 59 (1): 82–85. doi: 10.3760/cma.j.issn.0578-1426.2020.01.016.
18. *Ueda K, Takada D, Mii A, Tsuzuku Y, Saito SK, Kaneko T et al*. Severe thiamine deficiency resulted in Wernicke's encephalopathy in a chronic dialysis patient. *Clin Exp Nephrol*. 2006; 10: 290–293. doi: 10.1007/s10157-006-0440-9.
19. *Nakashima Y, Ito K, Nakashima H, Shirakawa A, Abe Y, Ogahara S et al*. Wernicke's encephalopathy that developed during the introduction period of peritoneal dialysis. *Intern Med*. 2013; 52: 2093–2097. doi: 10.2169/internalmedicine.52.9427.
20. *Kim CS, Bae EH, Ma SK, Kim SW*. The case seizure, ophthalmoplegia, and amnesia in a peritoneal dialysis patient. *Kidney Int*. 2016; 90 (6): 1389–1390. doi: 10.1016/j.kint.2016.06.015.
21. *Nishimura Y*. Wernicke's encephalopathy after cardiac surgery. *Asian Cardiovasc Thorac Ann*. 2018; 26 (4): 302–304. doi: 10.1177/0218492318772693.
22. *Galvin R, Bråthen G, Ivashynka A, Hillbom M, Tanasescu R, Leone MA*. EFNS guidelines for diagnosis, therapy and prevention of Wernicke encephalopathy. *Eur J Neurol*. 2010; 17 (12): 1408–1418. doi: 10.1111/j.1468-1331.2010.03153.x.
23. *Butt I, Ulloa N, Surapaneni BK, Kasmin F*. Refeeding syndrome and non-alcoholic Wernicke's encephalopathy in a middle-aged male initially presenting with gallstone pancreatitis: A clinical challenge. *Cureus*. 2019; 11 (7): e5156. doi: 10.7759/cureus.5156.
24. *Danovich GM*. Immunosupressivnye preparaty i protokoly dlya transplantatsii pochki. *Transplantatsiya pochki* / Per. s angl. pod red. Ya.G. Moysyuka. M.: GEOTAR-Media, 2014: 167–260.
25. *Sánchez-Larsen Á, Segura T, García-Muñozguren S, Peinado-Ródenas J, Zamarro J, Hernández-Fernández F*. Cerebral Vasospasm and Wernicke encephalopathy secondary to adult cyclic vomiting syndrome: The role of magnesium. *BMC Neurol*. 2016; 16 (1): 135. doi: 10.1186/s12883-016-0660-x.
26. *Coughlan JJ, Mross T, Wafer M, Liston R*. Thiamine refractory Wernickes encephalopathy reversed with magnesium therapy. *BMJ*. 2016. doi: 10.1136/bcr-2016-218046.
27. *Pochineni V, Rondon-Berrios H*. Electrolyte and acid-base disorders in renal transplant recipients. *Front Med*. 2018; 5: 261. doi 10.3389/fmed.201800261

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