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Case Report

Radiology Section

MR Neuroimaging Findings in Adult Diabetic Patients- Two Case Reports

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ABSTRACT

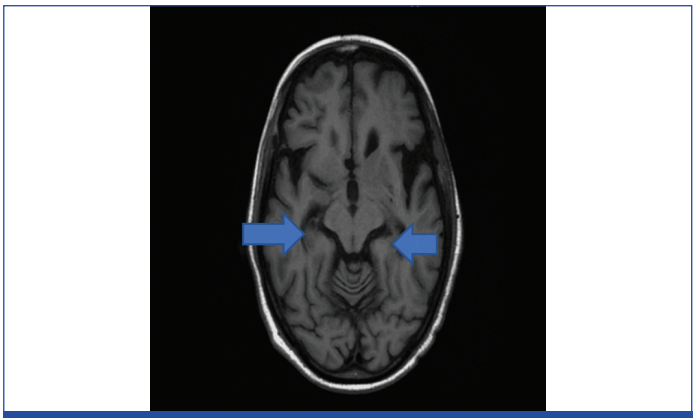
Diabetes Mellitus (DM) can affect any part of the central and peripheral nervous systems. Significant variations in glucose levels are often symptomatic. Hypoglycaemia as well as hyperglycaemia can present a wide variety of clinical symptoms. Imaging helps by suggesting the correct diagnosis and ensuring early treatment. We hereby present two cases, one of hypoglycaemic encephalopathy and a case of diabetic striatopathy. A 40-year-old female with a 25-year-old history of type 2 diabetes was brought into the emergency room in an unresponsive state since afternoon. The blood glucose was 28 mg/dL, and immediate administration of D 25%x2 stat was done. MRI revealed hyperintensities in the bilateral hippocampi and in the cortex of the bilateral high parietal region on T2WI/FLAIR. Despite intensive medical treatment the patient's neurologic condition didn't improve, due to irreversible brain tissue damage, and the patient ultimately died. A 63-year-old male was brought by relatives to causality with complaints of involuntary movements of the right-side of the body since three months, but symptoms have exaggerated since three days. Newly diagnosed DM since three months was on medication T.Metformin 500 mg BD. MRI revealed T1 hyperintensities in posterior half of left putamen. Patient was put on Inj. haloperidol 0.5 mg SOS, T.Aspirin 150 mg OD, T.Atorva 20 mg HS, T.sodium valproate 200 mg BD, T.tetrabenazine 25 mg BD and T.Serenace 0.5 mg BD and patient had improved symptomatically after 15 days of treatment. Imaging can play a crucial role in diagnosis and guide treatment and markedly influence the prognosis of patient.

Keywords: Diabetes mellitus, Diffusion-weighted imaging, Hemichorea-hemiballismus, Hypoglycaemic encephalopathy, Hyperglycaemia, Magnetic resonance imaging

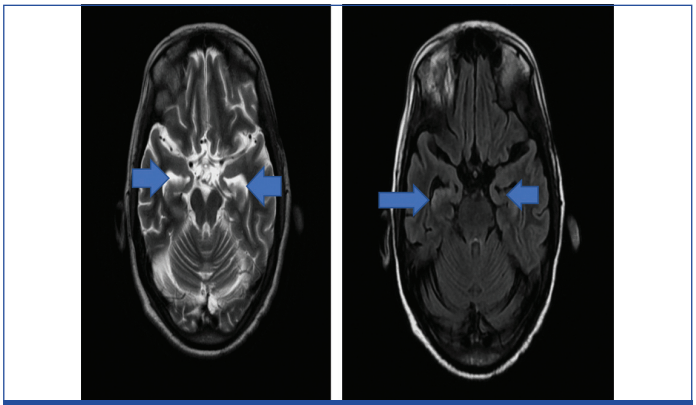
CASE 1

A 40-year-old female was brought into the emergency department after being found in an unresponsive state since the afternoon. She had a 25-year-old hi story of type 2 diabetes, receiving an insulin analogue (MI 24-0-14). Relative denied any medical history except for diabetes. She had undergone above knee amputation three months back in view of diabetic foot. The patient's physical examination was done. She could not open her eyes spontaneously and her pupils were normal and non reactive to light and accommodation. Bilateral plantar reflexes were absent. She had no purposeful speech and showed response to deep pain stimuli. There was decreased tone throughout all four extremities. She had no evidence of focal neurological deficit. Blood pressure was 100/70 mmHg; pulse 108 beats/min, respiratory rate 16 breaths/min; and temperature 36.1°C. The blood glucose was 28 mg/dL and immediate administration of D 25 %x2 stat. Computed tomography scan showed no significant findings of acute cerebrovascular injury. Hb A1c level was done and found to be 5.0%. The glucose blood levels were gradually corrected. She did not show any improvement even after corrective measures, so, MRI was advised. Neuroimaging with 3.0 T GE Discovery 750W MRI was carried out. MRI revealed subtle hypointensity on T1WI [Table/Fig-1], hyperintensities in bilateral hippocampi, and in the cortex of bilateral high parietal region on T2WI [Table/Fig-2]. It shows hyperintensities in bilateral hippocampi and in cortex of bilateral high parietal region on FLAIR images [Table/Fig-3]. It shows restricted diffusion on Diffusion-Weighted Imaging (DWI) [Table/Fig-4] and no blooming on Susceptibility-Weighted Imaging (SWI) images [Table/Fig-5].

Despite intensive medical treatment the patient's neurologic condition failed to improve. It resulted in irreversible brain tissue damage, and the patient ultimately died.



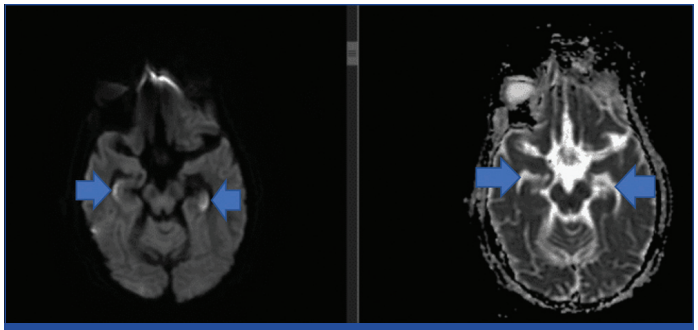
[Table/Fig-1]: T1W axial image showing subtle hypo intensity in bilateral hippocampi.



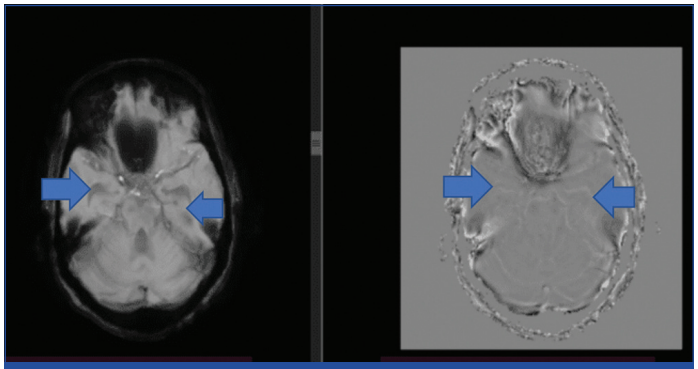
[Table/Fig-2]: T2W axial image showing subtle hyper intensity in bilateral hippocampi.
[Table/Fig-3]: FLAIR axial image showing subtle hyper intensity in bilateral hippocampi.
(Images from left to right)

CASE 2

A 63-year-old male was brought by relatives to causality with complaints of involuntary movements of the right-side of the body since three months, but symptoms have exaggerated since three days. He was known hypertensive and on treatment for 10 years and chronic alcoholic and tobacco chewer and abstinence since three months. Newly diagnosed DM since three months. On clinical

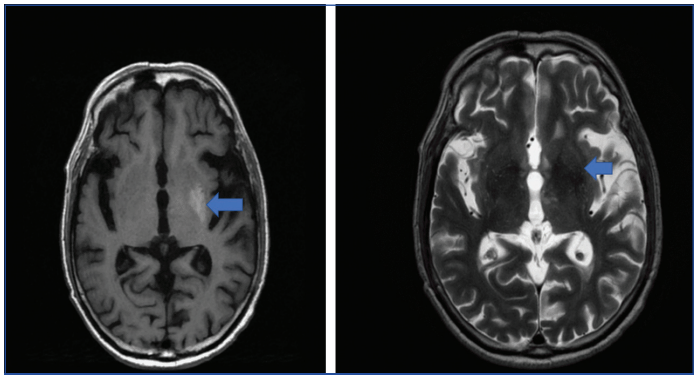


[Table/Fig-4]: Diffusion-Weighted Imaging (DWI) and corresponding Apparent Diffusion Coefficient (ADC) axial image showing restricted diffusion in bilateral hippocampi.



[Table/Fig-5]: Susceptibility Weighted Imaging (SWI) with phase sequence showing no foci of blooming.

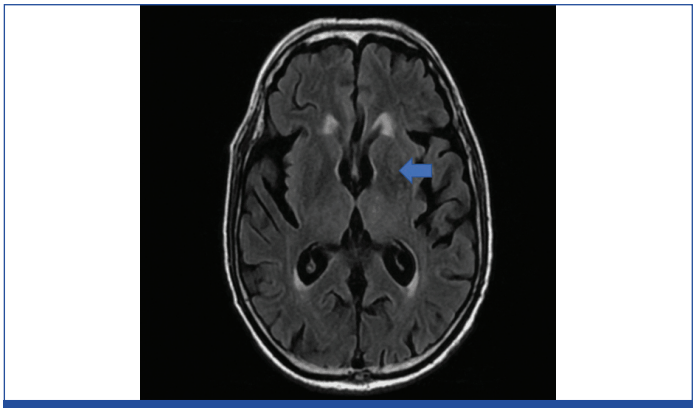
examination Blood pressure was 90/60 mmHg; pulse 84 beats/min, respiratory rate 16 breaths/min; and temperature 36.1°C. Neurological examination revealed normal power in all four limbs but exaggerated deep tendon reflex on the right-side. NCCT brain revealed no significant abnormality except mild senile atrophy. He was diagnosed with right hemiballismus in hypertension and DM. To investigate the cause of hemiballismus MRI brain was advised. It revealed T1 hyperintensities [Table/Fig-6] in posterior half of left putamen. It appears isointense on T2W/FLAIR images [Table/Fig-7,8] showing non restriction on DWI [Table/Fig-9] and no blooming on GRE images [Table/Fig-10]. There was no postcontrast enhancement. Patient was put on Inj. haloperidol 0.5 mg SOS, T.Aspirin 150 mg OD, T.Atorva 20 mg HS, T.sodium valproate 200 mg BD, T.tertabenzine 25 mg BD and T.Serenace 0.5 mg BD and the patient had improved symptomatically after 15 days of treatment.



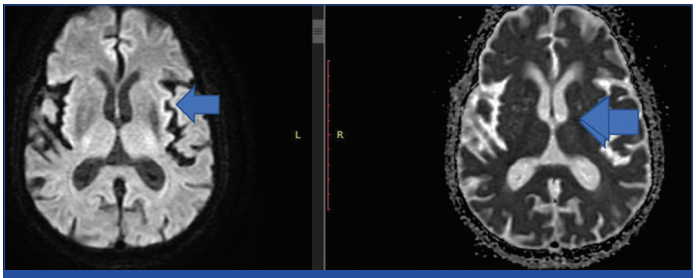
[Table/Fig-6]: T1W axial image showing hyperintensity in left putamen.
[Table/Fig-7]: T2W axial image no changes in left putamen in T2W images. (Images from left to right)

DISCUSSION

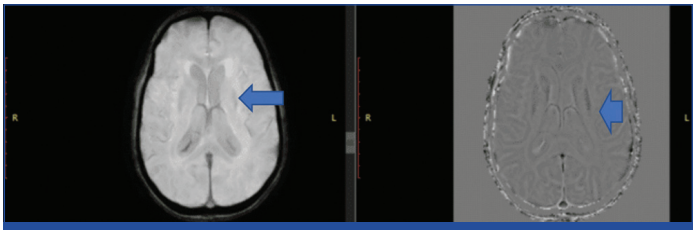
The DM can affect any part of the central and peripheral nervous systems [1]. The neurologic symptoms of treatment-related hypoglycaemia vary and include memory loss, motor function deficits, a persistent vegetative state, and deep coma, or even death [2]. Hyperglycaemic patients may present with Hemichorea-Hemiballismus (HC-HB), weakness, hypotonia, pyramidal tract signs, and seizures [1,3,4]. In addition to the blood index and past medical history, the imaging examination provides important information [5].



[Table/Fig-8]: No altered signal in left putamen on FLAIR images.



[Table/Fig-9]: Diffusion-Weighted Imaging (DWI) with corresponding ADC Images showing no restriction in DWI.



[Table/Fig-10]: Susceptibility-Weighted Imaging (SWI) with phase sequence showing no foci of blooming.

In emergency settings, it is not uncommon for these symptoms to be diagnosed and treated initially as stroke [6]. Imaging in such cases can play a vital role by suggesting the correct diagnosis and ensuring early treatment. This is vital because delayed diagnosis affects morbidity and mortality [2].

The physiologic postabsorptive blood glucose concentration range is 4.0-6.0 mmol/L [7]. When blood glucose is lower than 2.9 mmol/L, it causes brain condition such as hypoglycaemic encephalopathy [5]. Hypoglycaemia can be caused by a spectrum of medical conditions but is most commonly a result of underlying DM. Hypoglycaemia in Type 1 Diabetes occurs due to the reduced sympathetic responses seen in many patients while overdosage of oral hypoglycaemic agents is the most common cause in Type 2 patients [8]. Our patient was Type 2 DM on treatment with oral hypoglycaemics which was recently shifted to insulin during the amputation surgery.

The clinical manifestations of hypoglycaemia are complex. It is associated with the extent, speed, duration, and responsiveness of blood glucose levels [5]. Mild degrees of hypoglycaemia cause symptoms including pale skin, hunger, sweating and associated sympathetic symptoms including tremors, palpitations and anxiety. With the prolonged duration of symptoms, focal deficits including hemiplegia, aphasia, hemianopia, and cortical blindness are seen. Severe cases lead to decerebrate posturing, lethargy, vegetative states and coma [9].

The parts of the brain having a very high energy consumption are affected. It includes areas like the cerebral cortex, hippocampus, cerebellum, caudate nucleus, and the globus pallidus of the basal ganglia [10]. The main pathological changes of hypoglycaemic encephalopathy are extensive denaturation and necrosis of the neurons due to lack of energy and infiltrating glial cells [10]. One

theory states that hypoglycaemia causes a relative failure of Krebs cycle leading to production of increasing quantities of oxaloacetate from aspartic acid [9]. The characteristic neuropathology is the destruction of dendrites due to the location of receptors. Calcium fluxes occur, and membrane breaks in the cell lead rapidly to neuronal necrosis [11].

Magnetic Renosance Imaging (MRI) in hypoglycaemic coma mainly involves the cortex, internal capsule, basal ganglia, and hippocampus [12-14]. Distinct from routine MRI, DWI MRI can demonstrate an abnormal signal within minutes. Furthermore, compared with MRI, diffusion-weighted MRI defines only fresh lesions [15]. If the hyperintensity lesions regress in the second image, the patient will likely recover. However, if the hyperintensity lesions do not regress in the second image, the outcome will be poor [1]. However, in this case, the patient's prognosis was bad, and died, and no follow-up scan could be obtained. Aoki T et al., suggested that diffusion-MRI is a useful tool for the early diagnosis of severe hypoglycaemia and for predicting prognosis. In present case, hyperintensities were noted in the bilateral hippocampi and in the cortex of the bilateral high parietal region.

In approximately, 20% of acute hypoglycaemia cases, the imaging features of DWI are similar to those of ischemic stroke [2,6,11].

Although infarction and hypoglycaemia exhibit similar findings on diffusion-weighted MRI, their mechanisms are distinct. Determination of the blood glucose levels and the effects of glucose infusion are useful tools for differential diagnosis. Another method is to compare the diffusion-weighted MRI on the day of admission to one taken several days after glucose infusion. In the case of infarction, a hyperintense lesion on diffusion weighted MRI is unlikely to disappear within several days [15]. Second, abnormal MR images did not conform to vascular distributions, and MRA showed no abnormalities, which can exclude the cerebrovascular disease [5].

It is critical to diagnose hypoglycaemic encephalopathy as early as possible. Prompt treatment and recognition of hypoglycaemia have resulted in good outcomes. In conclusion, the diagnosis of acute symptomatic hypoglycaemic encephalopathy through clinical and imaging features can be challenging. It is crucial to differentiate it from ischemic infarction since the management and clinical outcome are different [8].

Hyperglycaemic patients may present with HC-HB, weakness, hypotonia, pyramidal tract signs, and seizures [1,3,4].

Hyperglycaemia leads increase in cerebrovascular resistance because of hyperviscosity and higher brain water content, leading to global reduction of cerebral blood flow leading to intracellular acidosis secondary to impaired metabolism [16]. Hyperglycaemia leads to dysfunction of the gabaminergic projection neurons from striatum [17]. It leads to reduced inhibitory gabaminergic projection on thalamus leading to increased thalamocortical excitatory drive [18].

The most consistent and common feature on MRI of the patients presenting with non ketotic hyperglycaemic HC-HB is hyperintense signal of the contralateral putamen on T1W images without surrounding oedema or mass effect [17-21].

These neuroimaging changes associated with contralateral movement disorders in diabetic hyperglycaemic patients is termed "diabetic striatopathy" or "diabetic striatal disease [22]. In our case, hyperintensity on T1WI is noted in posterior half of left putamen.

Yahikozawa H et al., proposed that the intensity change was due to calcium deposition or some other material in neurons or glial cells [23]. But follow-up neuroimaging findings showed the disappearance of hyperintense basal ganglia lesions. Therefore, it had been thought to represent petechial haemorrhage rather than calcification.

Mestre T et al., suggested that petechial haemorrhages due to erythrocyte diapedesis resulting from hyperglycaemia-induced blood-brain barrier dysfunction, leading to extravascular hemosiderin deposition along with ferruginateous deposits on perforating vessels [24].

Reducing blood glucose level is the treatment for hyperglycaemia-induced abnormal movements. Abnormal movements subside within days of normal blood glucose level [14,18,21,25,26]. The treatment of HC-HB or generalised chorea has been reported with various typical and atypical antipsychotics [1].

CONCLUSION(S)

Significant variations in glucose levels are symptomatic and can present acutely in the emergency department. Timely and accurate diagnosis is necessary to guide the treatment. Imaging can play a crucial role in diagnosis and guide treatment and markedly influence the prognosis of the patient. In our cases, MRI was useful in diagnosing the cause of HC-HB as diabetic striatopathy and treatment with controlling blood sugar and antipsychotics helped in the resolution of symptoms and improved the quality of life of the patient. However, in the case of hypoglycaemic encephalopathy, the patient presented with irreversible brain injury. Thus, MRI helped in diagnosing the cause of the unresponsiveness of the patient but since the patient already had an irreversible injury, the patient could not survive.

REFERENCES

[1] Jagota P, Bhidayasiri R, Lang A. Movement disorders in patients with diabetes mellitus. J Neurol Sci. 2012;314(1-2):05-11. Doi: 10.1016/j.jns.2011.10.033.
[2] Kang E, Jeon S, Choi S, Song C, Yu I. Diffusion MR imaging of hypoglycemic encephalopathy. AJNR Am J Neuroradiol. 2010;31(3):559-64. Doi: 10.3174/ajnr.a1856.
[3] Bandyopadhyay SK, Dutta A. Hemifacial spasm complicating diabetic ketoacidosis. J Assoc Physicians India. 2005;53:649-50.
[4] Sabitha KM, Girija AS, Vargese KS. Seizures in hyperglycemic patients. J Assoc Physicians India. 2001;49:723-26.
[5] Ren S, Chen Z, Liu M, Wang Z. The radiological findings of hypoglycemic encephalopathy. Medicine. 2017;96(43):e8425. Doi: 10.1097/md.0000000000008425.
[6] Yong AW, Morris Z, Shuler K, Smith C, Wardlaw J. Acute symptomatic hypoglycaemia mimicking ischaemic stroke on imaging: A systemic review. BMC Neurol. 2012;12:139. Doi: 10.1186/1471- 2377-12-139.
[7] Cryer P, Davis S, Shamoon H. Hypoglycemia in diabetes. Diabetes Care. 2003;26(6):1902-12. Doi: 10.2337/diacare.26.6.1902.
[8] Chuang KI, Hsieh KL, Chen CY. Hypoglycemic encephalopathy mimicking acute ischemic stroke in clinical presentation and magnetic resonance imaging: A case report. BMC Med Imaging. 2019;19(1):11. Doi: 10.1186/s12880-019-0310-z.
[9] Balagopal K, Suku S, Ebrahim A. A case of severe hypoglycemic encephalopathy. IP Indian Journal of Neurosciences. 2022;8(1):74-77. Doi: 10.18231/j.ijn.2022.014.
[10] Guettier JM, Gorden P. Hypoglycemia. Endocrinol Metab Clin North Am. 2006;35(4):753-66. Doi: 10.1016/j.ecl.2006.09.005.
[11] Schmidt P, Böttcher J, Ragoschke-Schumm A, Mentzel H, Wolf G, Müller U, et al. Diffusion-weighted imaging of hyperacute cerebral hypoglycemia. AJNR Am J Neuroradiol. 2011;32(7):1321-27. Doi: 10.3174/ajnr.a2464.
[12] Boeve B, Bell D, Noseworthy J. Bilateral temporal lobe MRI changes in uncomplicated hypoglycemic coma. Can J Neurol Sci. 1995;22(1):56-58. Doi: 10.1017/s031716710004052x.
[13] Finelli P. Diffusion-weighted MR in hypoglycemic coma. Neurology. 2001;57(5):933-33. Doi: 10.1212/wnl.57.5.933-a.
[14] Chan R, Erbay S, Oljeski S, Thaler D, Bhadelia R. Hypoglycemia and diffusion-weighted imaging. J Comput Assist Tomogr. 2003;27(3):420-23. Doi: 10.1097/00004728-200305000-00020.
[15] Aoki T, Sato T, Hasegawa K, Ishizaki R, Saiki M. Reversible hyperintensity lesion on diffusion-weighted MRI in hypoglycemic coma. Neurology. 2004;63(2):392-93. Doi: 10.1212/01.wnl.0000130181.05016.68.
[16] Duckrow R, Beard D, Brennan R. Regional cerebral blood flow decreases during hyperglycemia. Ann Neurol. 1985;17(3):267-72. Doi: 10.1002/ana.410170308.
[17] Lee E, Choi J, Lee S, Song S, Lee Y. Hemichorea-Hemiballism in primary diabetic patients: MR correlation. J Comput Assist Tomogr. 2002;26(6):905-11. Doi: 10.1097/00004728-200211000-00009.
[18] Kandiah N, Tan K, Lim C, Venketasubramanian N. Hyperglycemic choreoathetosis: Role of the putamen in pathogenesis. Mov Disord. 2009;24(6):915-19. Doi: 10.1002/mds.22277.
[19] Shan DE, Ho DM, Chang C, Pan HC, Teng MM. Hemichoreahemiballism: An explanation for MR signal changes. AJNR Am J Neuroradiol. 1998;19(5):863-70.
[20] Oh S, Lee K, Im J, Lee M. Chorea associated with non ketotic hyperglycemia and hyperintensity basal ganglia lesion on T1-weighted brain MRI study. J Neurol Sci. 2002;200(1-2):57-62. Doi: 10.1016/s0022-510x(02)00133-8.

[21] Lin J, Lin G, Shih C, Shen W. Presentation of striatal hyperintensity on T1-weighted MRI in patients with hemiballism-hemichorea caused by non ketotic hyperglycemia: Report of seven new cases and a review of literature. J Neurol. 2001;248(9):750-55. Doi: 10.1007/s00415017008.
[22] Abe Y, Yamamoto T, Soeda T, Kumagai T, Tanno Y, Kubo J, et al. Diabetic striatal disease: Clinical presentation, neuroimaging, and pathology. Intern Med. 2009;48(13):1135-41. Doi: 10.2169/internalmedicine.48.1996.
[23] Yahikozawa H, Hanyu N, Yamamoto K, Hashimoto T, Shimozono K, Nakagawa S, et al. Hemiballism with striatal hyperintensity on T1-weighted MRI in diabetic patients: A unique syndrome. J Neurol Sci. 1994;124(2):208-14. Doi: 10.1016/0022-510x(94)90328-x.
[24] Mestre T, Ferreira J, Pimentel J. Putaminal petechial haemorrhage as the cause of non ketotic hyperglycaemic chorea: A neuropathological case correlated with MRI findings. J Neurol Neurosurg Psychiatry. 2007;78(5):549-50. Doi: 10.1136/jnnp.2006.105387.
[25] Mihai C, Catrinoiu D, Stoicescu R. Atypical onset of diabetes in a teenage girl: A case report. Cases J. 2008;1(1):425. Doi: 10.1186/1757-1626-1-425.
[26] Lin J, Chang M. Hemiballism-hemichorea and non ketotic hyperglycaemia. J Neurol Neurosurg Psychiatry. 1994;57(6):748-50. Doi: 10.1136/jnnp.57.6.748.

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