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MR IMAGING IN BASAL GANGLIA LESIONS

Radiology

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ABSTRACT

Introduction: Bilaterally symmetrical abnormalities of the basal ganglia are common usually in diffuse systemic and metabolic diseases. Study is aimed to identify the spectrum of diseases involving basal ganglia disease and also to evaluate other sites of involvement in these patients.

Material and methods: 30 patients referred to our hospital with suspicion of basal ganglia lesions subjected to MR examinations by 3T MR system using a 32-channel phased array head coil.

Results: Most common etio-pathologies affecting basal ganglia are metabolic diseases (65%), infective etiology like dengue encephalitis (14%), Neoplasm's Glioma (10%) and degenerative disease like Huntington's disease (3%) respectively. Among metabolic diseases Hypoxic ischemic encephalopathy (27%) is the most common entities followed by hepatic encephalopathy (22%) and posterior reversible encephalopathy syndrome (4%) diagnosed respectively. Among the Thirty patients with basal ganglia lesions, bilateral symmetrical involvement in 22 cases (73%), unilateral involvement in 2 cases (7 %) and bilateral asymmetrical involvement in 6 cases (20%). There are 6 cases with Caudate +Putamen, 5 cases with Putamen + globus pallidus and 3 cases with entire basal ganglia (Corpus striatum) involvement in metabolic disease patients.

Conclusion: MR imaging has dramatically improved the ability to visualise deep grey structures of basal ganglia and spectrum.

KEYWORDS

INTRODUCTION

The deep grey matter structures of the basal ganglia comprise the caudate nucleus, putamen and globus pallidus. Computed tomography (CT) and magnetic resonance (MR) imaging have dramatically improved the ability to visualize the deep gray structures of the basal ganglia[1].They form the key components of the extrapyramidal motor system, and receive projections from almost every region of the cerebral cortex, playing a vital role in integrating movement[2]. MRI allows detailed visualization of the morphology, signal intensity and metabolic content of the DGM nuclei, together with visualization of normal cortical development and normal myelination of the white matter. The basal ganglia have high energy adenosine triphosphate (ATP) produced by oxidative phosphorylation within the mitochondria] requirements, increased blood flow and are rich in neurotransmitters and trace metals such as iron, copper and manganese. Hence, they are vulnerable to any systemic disease or generalised process that alters cerebral metabolism, which can lead to selective damage to the basal ganglia. However, damage to the deep grey matter nuclei may be visualised either as basal ganglia lesions in isolation or as part of more generalised brain damage also involving other grey or white matter structure[2]. Among the many causes of basal ganglia damage, bilateral symmetrical lesions typically are caused by diffuse systemic or metabolic conditions. Often, the cause (for example hypoxic ischemic encephalopathy in the context of cardiac arrest) is readily evident, but sometimes, the radiologist is faced with situations of bilateral symmetrical lesions in the basal ganglia for initial diagnosis (for example, coma of unknown cause) before the results of relevant investigations are known. There is considerable variation and overlap in both the clinical and radiologic features of abnormalities affecting the deep gray matter nuclei. Hence, no classification scheme is fool proof[3]. The systematic approach to this uncommon group of systemic and metabolic conditions is often challenging, but assessment of all the neuroimaging findings (not merely of the basal ganglia but other features) is an essential component for final diagnosis and sometimes prognosis[2]. The neuroimaging diagnosis is influenced not only by detection of specific MR imaging features such as restricted diffusion and the presence of haemorrhage, but also by detection of abnormalities involving other parts of the brain, especially the cerebral cortex, brainstem, and white matter. Judicious use of confirmatory neuroimaging investigations, especially diffusion-weighted imaging, MR angiography, MR venography during the same examination, may help improve characterization of these abnormalities and help narrow the differential diagnosis[3]. Recognition and correct evaluation of basal ganglia abnormalities, together with a proper clinical history and laboratory findings, may enable the identification of spectrum of disease entities and lead to earlier diagnosis[4]. Reaching a diagnosis in the early stages of acute diseases in many patients is crucial for instigating prompt specific therapy leading to a favourable outcome[5]. The neuroradiologist can thus play an important role in contributing imaging features to the overall clinical, biochemical and genetic picture that makes up an accurate picture of patients with systemic and metabolic disease[2]. The aim of the study was to evaluate the spectrum of pathologic conditions of basal ganglia involvement (Excluding vascular pathologies), and the radiological assessment of these conditions with clinical correlation.

MATERIAL AND METHODS

Patients attending the department of Radio-diagnosis, Smt. NHL Medical college and SVPIMSR , Ahmedabad were the main source of data for this study. All patients referred to the department of Radiology with clinical suspicion of basal ganglia (deep grey matter) lesions in a period of 1 ½ yrs from January 2019 to March 2020 will be subjected for study. Total 30 patients with basal ganglia involvement were included based on inclusion criteria.

Inclusion Criteria: Patients with extrapyramidal symptoms, patients with suspected metabolic encephalopathy, all patients with incidentally diagnosed basal ganglia lesions by CT, follow up patients of basal ganglia lesions, cases of all age groups irrespective of sex.

Exclusion Criteria: Vascular pathologies of basal ganglia (Infarcts and haemorrhages), Patient having history of claustrophobia, Patient having history of metallic implants insertion, cardiac pacemakers and metallic foreign body in situ.

Equipment: The MR examinations were performed on all patients who met inclusion criteria at a 3T whole-body MR system using a 32-channel phased array head coil. Sequences: Conventional spin echo sequences, axial T1, T2 and FLAIR: Coronal FLAIR, DWI; SWAN and Postcontrast T1+C if required.

STATISTICAL ANALYSIS

RESULTS

Total 30 patients were evaluated with basal ganglia involvement. Thirty patients were evaluated, whose age group ranged from1 to >60

years. The highest incidence of basal ganglia lesions were found in 21-30 years age group accounting for 26% of cases (8 cases) and least was seen in age group of 41-50 years constituting 3% (1 case). Thirty patients were evaluated of which 18 (60%) were males and 12 (40%) were females. Out of the 30 patients who were evaluated, Metabolic diseases accounts for 22 cases (73%) and is the most common pathology followed by infectious diseases representing 4 cases (14%), Neoplasm's accounting for 3 cases (10%) and degenerative diseases involving 1 case (3%). Among metabolic diseases, there are 6 cases each with Hypoxic ischemic encephalopathy, 3 cases with hypoglycemic encephalopathy, 1 case with PRES, 2 cases each with hyperglycemic encephalopathy, and extrapontine myelinosis, 5 cases with hepatic encephalopathy, 3 case with Wilson's disease.

All the patients with basal ganglia lesions, seizures are the most common presentation followed by altered mental state especially in acute cases like metabolic, infectious and degenerative diseases. Extrapyramidal symptoms (Gait disturbances, abnormal dancing movement, hypertonia, dystonia, rigidity etc.) are the common presentation in chronic cases like degenerative and neoplasm's.

20 cases of total cases is identified to be bilateral symmetrical side of pathology in basal ganglia lesions. Among Thirty patients, 26 (86%) cases showed diffusion restriction (partial/complete) and 4 (14%) cases showed no restriction.

Out of Thirty patients evaluated, metabolic diseases are seen in 22 cases (73%). Among the 22 cases Males were 12 and Females were 10. Bilateral symmetrical involvement of basal ganglia is seen in 20 cases (91%) and unilateral involvement is noted in 2 case (9%).

Most common primary basal ganglia nuclei involved was caudate nucleus and putamen in 6 cases (28%), followed by putamen and GP in 5 cases (22%), globus pallidus in 5 cases (22%), corpus striatum in 3 cases (13%), involving putamen in 2 cases (9%) and only caudate nucleus in 1 case (6 %). Involvement of most common site of neuroparenchyma in addition to basal ganglia includes BG + Thalamus in 3 cases (13%), followed by BG + Cortex in 5 cases (23%), BG + Cortex + White matter in 5 cases (23%), BG + White matter in 4 cases (18%) and finally BG + Brainstem in 3 cases (13%).

Distribution of the basal ganglia nucleus involvement among the metabolic disease.

Pathology	Caudate only	Caudate and putamen	Putamen only	Putamen & GP	GP only	Corpus striatum
HIE	1	1	-	2	-	2
Hypoglycemic Encephamopathy	-	-	-	2	-	1
Hyperglycemic encephalopathy	-	2	-	-	-	-
Hepatic encephalopathy	-	-	-	-	5	-
PRES	-	1	-	-	-	-
Osmotic myelinosis	-	1	-	1	-	-
Wilson's disease	-	1	2	-	-	-

Distribution of primary basal ganglia involvement along with other areas of brain parenchymal involvement in various metabolic diseases

Pathology	Basal ganglia + thalamus	Basal ganglia + cortex	Basal ganglia + white matter	Basal ganglia + brain stem	Basal ganglia + cortex and white matter
HIE	1	2	1	-	2
Hypoglycemic Encephamopathy	-	2	2	-	2
Hyperglycemic encephalopathy	-	-	-	-	-
Hepatic encephalopathy	-	-	-	-	-
PRES	-	1	1	-	1
Osmotic myelinosis	-	-	-	2	-
Wilson's disease	2	-	-	1	-

DISCUSSION

Magnetic resonance imaging is a non-invasive and accurate method with better contrast that demonstrates the lesion accurately. So with help of MRI there is better assessment of basal ganglia lesion. Aim is to study various MR appearance in different basal ganglia lesion. In our study of MR imaging of basal ganglia lesions, we evaluated 30 patients. Out of the 30 patients who were evaluated, Metabolic diseases accounts for 22 cases (73%) and is the most common pathology followed by infectious diseases representing 4 cases (14%), Neoplasm's accounting for 3 cases (10%) and degenerative disease involving 1 cases (3%). Finelli et al,[6] in his case series study stated, metabolic conditions were the most common cause of acute bilateral symmetric DGMN lesions. Among metabolic diseases HIE (27%) are the most common entities followed by hepatic encephalopathy (23%), hypoglycemic encephalopathy (14%) and PRES, hyperglycemic encephalopathy, Wilson disease and extrapontine myelinolysis are other fewer pathologies accounting for rest of the metabolic diseases (35%). Viral encephalitis like dengue encephalitis are the most common pathologies under infectious diseases. Glioma and DNET are the pathologies included under Neoplasm's. Huntington's disease is the disease entities which represents the degenerative diseases. Among thirty patients with basal ganglia lesions, seizures are the most common presentation followed by altered mental state especially in acute cases like metabolic and infectious diseases Extrapyramidal symptoms (Gait disturbances, abnormal dancing movement, hypertonia, dystonia, rigidity etc,) are the common presentation in chronic cases like degenerative and neoplasm's. Among the Thirty patients with basal ganglia lesions, bilateral symmetrical involvement noted in 22 cases (73%), unilateral involvement noted in 2 cases (7%) and bilateral asymmetrical involvement noted in 6 cases (20%).

Among Thirty patients who were evaluated; 26 (86%) cases showed diffusion restriction (partial/complete) and 4 (14%) cases showed no restriction. Out of thirty patients, metabolic diseases are seen in 22 cases (73%). Among the 22 cases Males were 12 and Females were 10. Bilateral symmetrical involvement of basal ganglia is seen in 20 cases (91%) and unilateral involvement is noted in 2 case (9%).

Most common primary basal ganglia nuclei involved was caudate nucleus and putamen in 6 cases (28%), followed by putamen and GP in 5 cases (22%), globus pallidus in 5 cases (22%), corpus striatum in 3 cases (13%), involving putamen in 2 cases (9%) and only caudate nucleus in 1 case (6 %). Involvement of most common site of neuroparenchyma in addition to basal ganglia includes BG + Thalamus in 3 cases (13%), followed by BG + Cortex in 5 cases (23%), BG + Cortex + White matter in 5 cases (23%), BG + White matter in 4 cases (18%) and finally BG + Brainstem in 3 cases (13%). Diffusion restriction was noted in 20 cases (91%) and in 2 cases (9%) no diffusion restriction is seen. Among 22 cases, various pathologies constitute the metabolic diseases.

The most common entity among the metabolic diseases are HIE (6 cases, 27%). HIE is the most common metabolic disease seen especially in adults. Cardiac arrest was the mechanism of injury in the majority of the patients of our study population (6 cases). Cardiac causes accounted for 16 out of 39 cases of hypoxic-ischemic insult in the study by Choi et al[7] and 14 out of 22 cases in the study by Topcuoglu et al[8]. Studies by Wu et al[9] Arbelaez et al[10] were focused only on patients with cardiac arrest as the cause of hypoxic -ischemic insult. Involvement of cerebral cortex (6 cases, 100%) was noted in association with basal ganglia noted in all cases. Thalamus involvement in addition to basal ganglia involvement is seen in 4 cases (67%). Hippocampal involvement in association with basal ganglia involvement noted in 3 cases (50%). Diffuse cortical and deep grey matter pattern with perirolandic involvement was the most frequent pattern across the major mechanism in a study by Eluvathingal Muttikkalet al.[8] Choi[7] et al, in their study of 39 patients categorized the brain injuries into four patterns: normal, isolated cortical injury, isolated deep grey nuclei injury, and mixed injuries (cortex and deep grey). Wu et al,[9] concluded that whole-brain median ADC was a predictor of poor outcome.

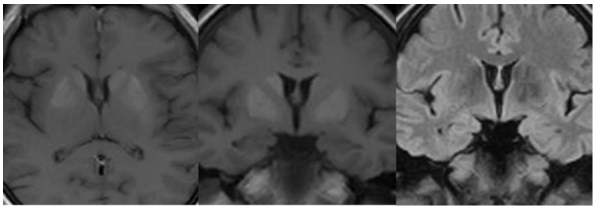
Serial MRI evaluation of 4 vegetative patients with profound hypoglycemia revealed signal intensity changes in caudate and lenticular nuclei, cerebral cortex, substantia nigra, and/or hippocampus from 8 days to 12 months after onset in a study by Masayuki Fujioka, et al[10].

Tchoyoson Lim et al[11] evaluated 7 patients with profound hypoglycemia, cerebral cortex involvement was seen in all cases and basal ganglia involvement was seen in 2 cases and are had poor outcome.

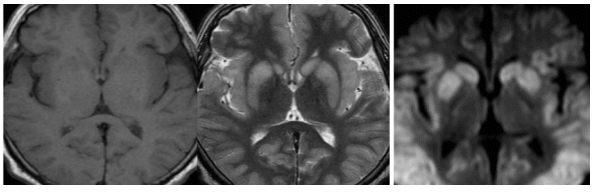
PRES (Posterior reversible encephalopathy syndrome) is the other entity accounting for 5% (1 cases). Bartynski et al,12 evaluated large cohort of 136 patients who experienced PRES to comprehensively assess the imaging patterns: Vasogenic edema was consistently present in the parietal or occipital regions (98%), but other locations were common including the frontal lobes (68%), inferior temporal lobes (40%), and cerebellar hemispheres (30%). Extrapontine myelinolysis accounts for 2 case (10%). Elderly female presented to casualty with gastroenteritis, considering the clinical condition patient has been vigorously treated with IV fluids following which patient had altered sensorium. Gary M. Miller et al,[13] reviewed 9 patients with CPM, all patients had basipontis involvement and extrapontine myelinolysis, were identified in three of the patients in the peniventricular white matter, basal ganglia, and corticomedullary junction bilaterally. Sabale Avinash et al,[14] reported two cases of patients with proven malignancy who developed extrapontine myelinolysis after treatment for hyponatremia. An early MRI of the brain in suspected/high-risk cases of osmotic myelinolysis may show features of extrapontine myelinolysis in the form of bilateral basal ganglia hyper intensity on T2W and FLAIR images and diffusion restriction with typical pallidal sparing. Hepatic encephalopathy accounts for 23% (5-case). Etsuo Inoue et al,[15] evaluated Sixteen patients with cirrhosis of the liver underwent cranial magnetic resonance (MR) imaging and transarterial portography to evaluate the relationship between basal ganglia lesions and portalsystemic collateral vessels. A Pujol et al[16] evaluated Seventy-seven patients with chronic liver disease, candidates for orthotopic liver transplantation with MRI The high-intensity signal in the globus pallidus on T1w MRI was observed in 58 (75%) patients. Wilson's disease is another rare entity accounting for 3 case (14%). Paediatric female child who has hepatic failure presented with psychomotor illness and movement disorder. Laboratory investigation revealed copper traces in urine. On MRI evaluation, there is bilateral symmetrical T2 and FLAIR hyper intensity involving lentiform nucleus, thalamus, midbrain and pontine tegmentum without diffusion restriction. T.J. Kim,I.O. Kimet al,[17] evaluated a cohort of pediatric Wilson disease patients in whom, the lentiform nuclei are involved most often, followed by the thalami, pons, midbrain, superior and middle cerebellar peduncles, and cerebellar nuclei. Bilateral asymmetrical involvement was seen in 3 cases (60%), unilateral involvement and bilateral symmetrical involvement noted each in 1 case20%).Diffusion restriction is seen in all cases100%). Thalamus involvement is seen in all cases (100%) with associated haemorrhage was seen in 2 cases (40%). Brainstem, cerebellum and deep white matter involvement was seen in 2 cases (40%). Basal cisterns, ventricles and meningeal enhancement are normal in all cases. Serology of 2 patients among encephalitis picture is positive for Dengue virus. The findings in rest of the 4 patients of our study reveals clinical features of encephalitis with negative dengue serology test and MRI imaging pattern shows deep grey matter and thalamic involvement which suggest the probability of JE and is considered in these 4 patients.J. Kalita et. al,[18] evaluated forty two patients with JE. Thalamic lesions on CT and/or MRI combined had sensitivity 23% (95% confidence interval 12.9–33.1%), specificity 100%, positive predictive value 100% and negative predictive value 42.1% (95% confidence interval 30.2–53.8%) for a diagnosis of JE in a cohort of 75 patients with suspected encephalitis in a study by N. M. Dung and Lance Turtle etal, (2009)[19]. U.K. Misraa, J. Kalitaa, [20] et.al, evaluated 88 consecutive viral encephalitis patients, of them 22 patients had JE, 9 had dengue, 8 had herpes simplex encephalitis (HSE), 2 had Epstein-Barr virus encephalitis (EBVE) and 47 had nonspecific encephalitis. Sanjeev Kumar etal,[21] evaluated twenty-one serologically confirmed patients of dengue with altered sensorium who underwent MRI in them was 20. MRI was abnormal in 9 (45%). SoniSR Das et al,[22] evaluated magnetic resonance imaging (MRI) findings of 3 patients with dengue fever diagnosed by positive dengue NS1 antigen revealed nonspecific imaging features of dengue encephalitis in two cases and dengue meningoencephalitis in one case in the form of diffuse cerebral oedema, bilateral symmetrical FLAIR and T2 hyper intensities in thalami, pons, and medulla with heterogenous or peripheral enhancement José M. García-Santos[23] et al, described among brain tumours, those arising from the deep brain are rare. In many cases they are low-grade astrocytomas followed by germ cell tumours. Wei Fu et al[24] retrospectively analyzed 35 children with PBGRT fromDecember 2011to December 2015. Most common were 15 astrocytomas and 11 germ cell tumours (GCT). DNET (Dysembryoplastic neuroepithelial tumour) is the other neoplasm seen in our study. Young adult patient presented with recurrent history of partial seizures. No obvious perilesional edema noted. Associated cortical dysplasia or cortical tubers are not seen in our study.On T1+ C contrast study, no obvious enhancement of lesion seen. Clinico-radiologic criteria for the diagnosis of DNET[25] are seen in our case. These findings were very much similar to our study result of DNET. Degenerative diseases are rare ones involving basal ganglia accounting for 1 cases (3%)in my study. These diseases are confined only to basal ganglia nuclei without involvement of rest of the neuroparenchyma. Bilateral symmetrical involvement without obvious diffusion restriction is seen. Case of degenerative disease included in my study was Huntington's disease, seen in a 40 yrs old male presenting with involuntary dancing movements (chorea). On evaluation, exclusive bilateral caudate and putamen (Caudate >Putamen) nucleus involvement noted in the form of atrophy. On axial images frontal horn of bilateral lateral ventricles appears as "Box Car" configuration.

CONCLUSION

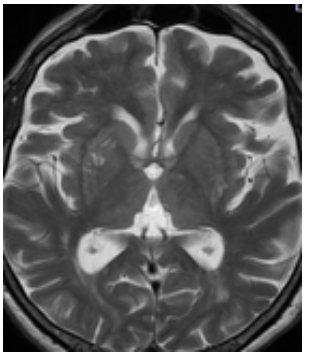
With the use of Magnetic Resonance Imaging there has better delineation of deep grey structures of basal ganglia and identifying of the diseases involving it. There is characteristic pattern of pathology involving the basal ganglia which helps in narrowing of the differential. Magnetic resonance imaging helps in correctly diagnosing with available clinical and laboratory data. Magnetic resonance imaging is useful in monitoring disease progression. It also has a prognostic implication.



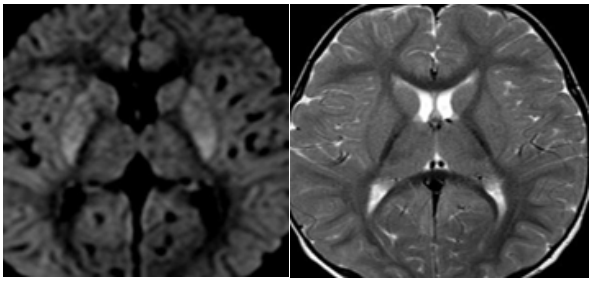
HYPERGLYCEMIA
T1W AND FLAIR MRI SHOWING CHANGES IN BASAL GANGLIA APPEARS HYPERINTENSE IN T1 WEIGHTED AND LOW SIGNAL IN FLAIR IMAGES



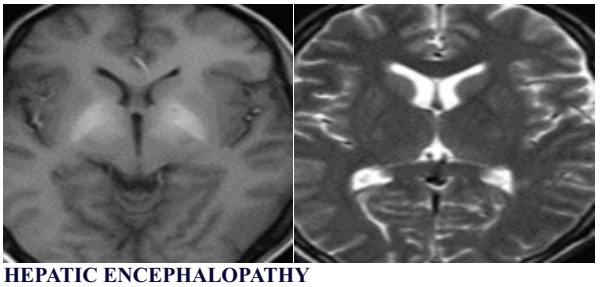
HYPOGLYCEMIA
T1WEIGHTED, T2WEIGHTED AND DIFFUSION WEIGHTED IMAGES: WIDESPREAD BASAL GANGLIA INVOLVEMENT IN HYPOGLYCEMIC PATIENT



WILSON DISEASE
T2 WEIGHTED AXIAL MR IMAGE: SHOWING SIGNAL CHANGES IN THE BASAL GANGLIA



HYPOXIC-ISCHEMIC ENCEPHALOPATHY DW IMAGE AND T2 WEIGHTED IMAGE WITH ABNORMAL HIGH SIGNAL INTENSITY IN THE BASAL GANGLIA



HEPATIC ENCEPHALOPATHY ON T1-WEIGHTED IMAGE, THE BASAL GANGLIA HAS PRONOUNCED HIGH SIGNAL INTENSITY IN GLOBUS PALLIDUS AND T2 IMAGE SHOWS HYPOINTENSE GLOBUS PALLIDUS

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