Research Article

Role of Magnetic Resonance Imaging in Diagnosis of Parkinsonism

Marwa M. Ahmed, Osama A. Khalil, Mohammed Gaber Essawy, and Manal F. Abosamra
Department of Radiodiagnosis, Faculty of Medicine – Minia University

Introduction

The spectrum of parkinsonian syndromes is wide and, due to the lack of specific biomarkers, their diagnosis remains largely clinical. Disorders that are most commonly referred to as 'atypical parkinsonism' comprise progressive supranuclear palsy (PSP), multiple system atrophy (MSA), corticobasal degeneration (CBD) and dementia with Lewy bodies (DLB). The characteristic features of these disorders are well recognised. However, these features may be absent or ambiguous at initial diagnosis and the clinician may be uncertain about the L-dopa response. Many atypical parkinsonism cases initially resemble idiopathic Parkinson's disease [(1)]

MRI plays an important role in the differential diagnosis in PD. Conventional MRI (cMRI), as well as different advanced MRI techniques, including magnetic resonance spectroscopy (MRS), diffusion-weighted and diffusion tensor imaging (DWI/DTI) and functional MRI (fMRI), are helpful to distinguish PD from APDs, especially in early stage of disease where a differentiation of these conditions is not easy. The principles of MRI are based on the ubiquitous presence of hydrogen in body tissues and the spin of the hydrogen atom proton, which induces a small magnetic field. In general, T2-weighted sequences are sensitive to changes in tissue properties, including tissue damage, due to changes of the transverse magnetization or T2 decay. Neuro degenerative processes are characterized by cell loss, increased age-related deposition of iron or other paramagnetic substances, and by astroglial reaction and microglial proliferation may lead to signal changes in affected brain areas, like the basal ganglia or infratentorial structures, in neurodegenerative parkinsonism[(2)]

Diffusion weighted MRI

Diffusion weighted imaging (DWI) is a novel MRI technique that allows for the assessment of brain micro structural integrity. It measures the movement of water molecules, which is mainly directed along the white matter fibers. Axonal damage and cell loss, as commonly observed in neurodegenerative diseases, lead to an increase in molecule movement, and consequently, the apparent diffusion coefficient[(3)]

Aim of the study

To evaluate the role of conventional MRI and diffusion weighted imaging (DWI) in diagnosis of Parkinsonism

Review

MRI finding in parkinsonism

The results of conventional MRI scans with T1-weighted, T2-weighted, proton density-weighted, or fluid-attenuated inversion recovery sequences are usually normal in Parkinson's disease. Thinning of the substantia nigra pars compacta and diffuse cortical atrophy can occur in patients with Parkinson's disease , although those changes are typically seen only in the later stages of the disease. In some instances, MR imaging may also demonstrate findings specific to particular APS. Morphologic changes, such as selective lobar atrophy, are typically better visualized on T1-weighted or fluid-attenuated inversion recovery (FLAIR) images, which highlight the contrast of high-signal central nervous system structures against low-signal cerebrospinal fluid. Increased T2 signal typically reflects varying degrees of wallerian degeneration, demyelination, and gliosis, whereas low T2 signal indicates the physiologic accumulation of paramagnetic sub-stances such as ferritin. Both increased and decreased T2 signal can be useful in identifying

particular APS, especially in cases that show classic patterns of T2 signal change. Conventional MR imaging is extremely useful for excluding structural abnormalities such as mass lesions, infarcts, or hydrocephalus, which may produce symptoms mimicking neurodegenerative disease[4].

Typical Parkinsonism (PD):

In early- stage of PD MR imaging findings are normal . While in many cases of PD Substantia nigra pars compacta (SNpc) loses normal hyperintensitiy and their margins become blurred

In advanced stage MRI shows narrowing and loss of the normal swallow tail appearance of substantia nigra[5].

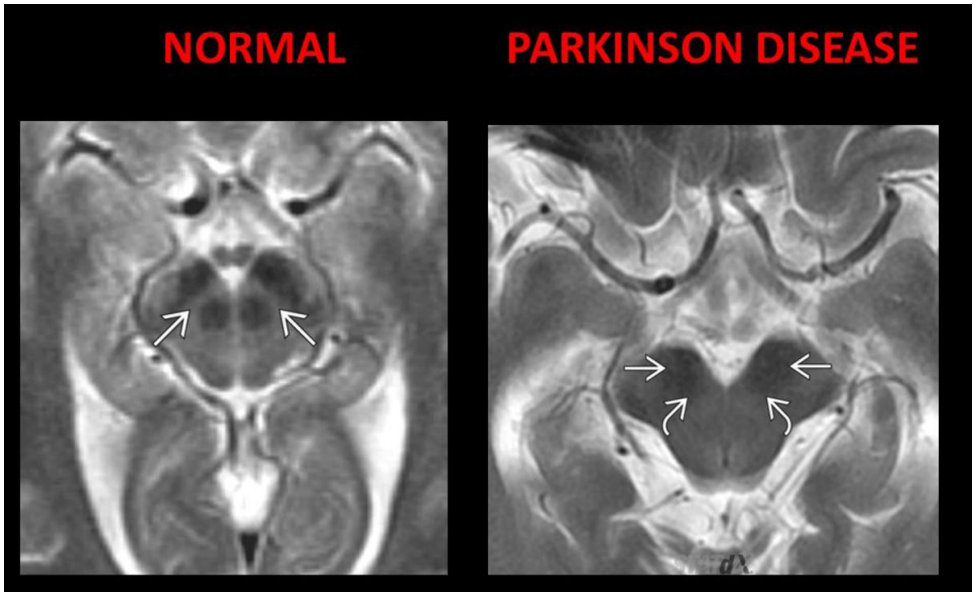


Fig. 1: Axial T2 MR images compare normal midbrain with Parkinson disease¨s midbrain.
A-Normal midbrain: White arrow demonstrate normal hyperintense Pars Compacta.
B-Parkinson disease's midbrain:
1-White straight arrow demonstrate Subestentia Nigra pars Reticularis.
2- White curved arrow demonstrate Red nucleus.
Second image shows blurring and thinning of pars compacta. Subsequently, the red nuclei and substantia nigra Pars Reticularis are almost touching.
Quoted from: Osborn AG, Blaser SI, Salzman KL, Katzman GL, Provenzale J, Castillo M, Hedlund GL, Illner A, Harnsberger HR, Cooper JA, Blaise VJ, Hamilton BE (2004) Diagnostic Imaging Brain. Salt Lake City, Utah: Amyrsis p I,8:59; I,8:67; I,8:70-73 [2] Spinner MA, Paulin HN, Wester CW (2012)[5].

Patients and Methods

The study included 40 patients presented with the clinical data of parkinsonism .They referred to the radiological department of Minia University hospital. There were (30 males and 10 females) and their age ranged between 57 and 75 years old. This occurred during the period from October 2017 to June 2018.

Inclusion Criteria:

Patients suspected clinically to have typical parkinsonism or Atypical parkinsonism based on history of tremors, rigidity, hypokinesia and postural instability.

Exclusion Criteria:

- Other causes of tremors, rigidity and hypokinesia rather than parkinsonism such as drug inducded tremors, stress and dehydration.
- Any contra indication to MRI examination as:
  - Patient who have a heart pace-maker.

- Patient who have aneurysmal clips.
- Patient with severe claustrophobia may not be able to tolerate an MRI scan.

Each patient was subjected to the following:

- Detailed history taking regarding duration of disease, progression of symptoms and presence of complications.
- Detailed clinical examination, neurological investigation such as electro encphalography (EEG) and if there were available other radiological studies including CT examination.

Patient preparation:

Patients were laid in a supine position and head coil was used. Patients head was immobilized by molded foam, which was placed around the head during the imaging procedure.

MRI Protocol:

- All subjects, including PD and APD patients were studied by routine image on brain and brainstem including:
  - T1: Axial and sagittal views.
  - T2 Axial and sagittal views.
  - T2 Flair axial view.
  - T2 axial and sagittal views with high resolution thin cut section 1mm thickness.

DWI /ADC value axial views

Results

Fourty patients; 30 males (75%) and 10 females (25%), clinically diagnosed as Parkinsonism were included in this study. Mean age was 67 years old (range between 57 to 75 years) and durations of disease range from 1 to 10 years with mean 5 years.

MRI finding of Parkinsonism can be summarized in (table) and (fig.).

Table: all radiological signs of typical and atypical parkinsonism

Parkinsonism N=40				
	Typical parkinsonism N=31	Atypical parkinsonism N=9		
Signs	**PD**	**PSP**	**CBD**	**MSA**
Thining of pars compacta	+ve 3 (9.7%)	-ve	-ve	-ve
Humming bird sign	-ve	+ve 4(44.4%)	-ve	-ve
Morning glory sign	-ve	+ve 4(44.4%)	-ve	-ve
Atrophy of SCP	-ve	+ve 4(44.4%)	-ve	-ve
Asymmetrical atrophy of cerebral cortex	-ve	-ve	+ve 5 (55.6%)	-ve
Cerebellar atrophy	-ve	-ve	-ve	-ve)
Atrophy of MCP	-ve	-ve	-ve	-ve
Atrophy of pons	-ve	-ve	-ve	-ve)
Hot cross bun sign	-ve	-ve	-ve	-ve
Putaminal rim sign	-ve	-ve	-ve	-ve

Table: Patients with radiological findings of parkinsonism

	Number of patients	Percentage
Positive	**12**	**30%**
Negative	**28**	**70%**
Total	**40**	**100**

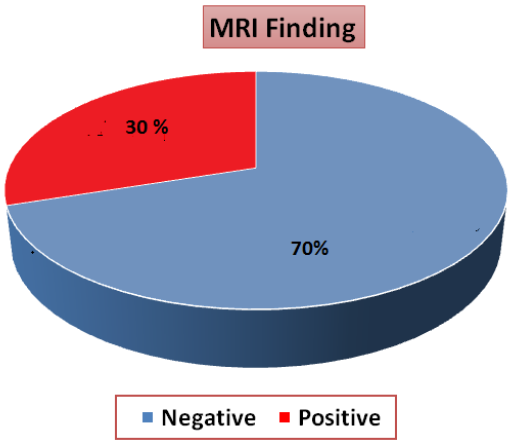


Fig. 2: Patients with radiological findings of parkinsonism

Case Presentation

Case 1

Clinical presentation:

A 69 year old male patient, presented to neurology out clinic of Minia University hospital presented with tremor on his both hand and stiffness of muscles of right hand, he suffer from psychic disturbance and change in mood and behavior.

Clinical examination

Clinical examination revealed presence of resting tremor in his both hands, rigidity of the muscles of upper limbs and psychic disturbanc so, diagnosed as Parkinsonism.

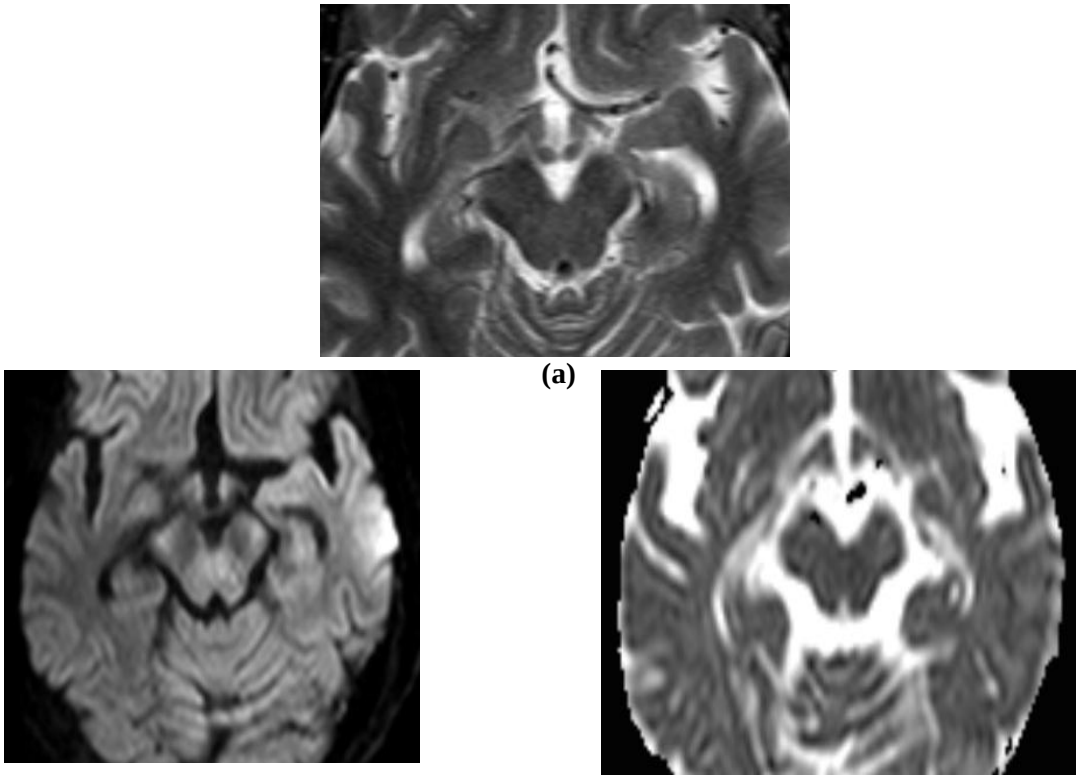
MRI finding

T2 high resolution thin cut sections 1 mm thickness axial view show:

Thining and blurring of Subestentia Nigra Pars Compacta of midbrain.

Diagnosis:

Idiopathic Parkinson disease {Typical parkinsonism}.



(a) **(b)** **(c)**

Fig. 3: Patient of PD: on (a) Axial T2 weighted view on Midbrain show Thining and blurring of Substentia Nigra Pars Compacta (SNPC). (b,c) Axial DWI and ADC show normal MRI finding.

Case 2

Clinical presentation:

A 72 year old male patient, presented to neurology out clinic of Minia University hospital presented with tremor in his left hand and stiffness of muscles of the affected hand patient also suffer from dizzness.

Clinical examination:

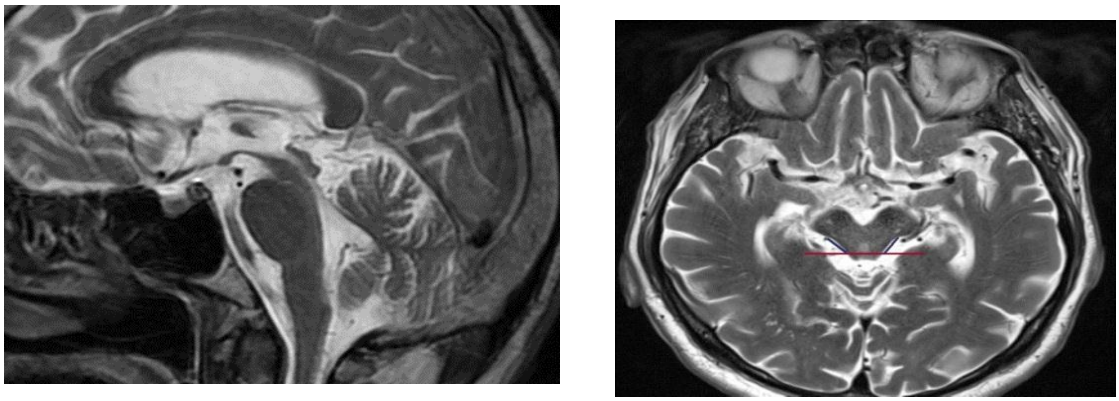
Clinical examination revealed presence of resting tremor on his left hand and rigidity of his muscles so, diagnosed as Parkinsonism.

MRI finding

- T2 weighted sagittal view high resolution on brainstem show flatening or concave outline to the superior aspect of midbrain "Humming bird sign".
- T2 weighted axial view high resolution on midbrain show Morning glory sign (concavity of lateral border of tegmentum of midbrain).

Diagnosis:

Progressive Supranclear Palsy {PSP}.



(a) **(b)**

Fig. 4: Patient of PSP: on (a) T2 sagittal view on brainstem show concavity of superior aspect of midbrain"Humming bird sign". (b) T2 axial view: a horizontal line (red line) drawn through the edge of the posterior cerebral aqueduct. a second line (blue line) is drawn along the lateral margin of the tegmentum from the intersection of the horizontal line to the "pit" between the tegmentum and the cerebral peduncle. the tegmentum is concave and the lateral margin runs inside the second line

Discussion

Parkinsonism is a group of conditions that are characterized by four typical motor symptoms of; tremor, rigidity, hypokinesia and postural instability. Parkinson's disease (typical parkinsonism) is the most common form of parkinsonism. Parkinsonism Plus syndromes or Atypical parkinsonism are group of conditions that cause symptoms like Parkinson's disease as well as other symptoms. They include; Progressive supranuclear palsy, Multiple system atrophy, Corticobasal degeneration and Dementia with Lewy body[(6)].

Parkinson's disease (PD) and the different forms of atypical parkinsonism (AP) are clinical diagnoses. Differentiating PD and AP on clinical parameters is challenging, especially in early disease courses. This is due to large overlap in symptoms and because the so called red flags, i.e. symptoms indicating AP, have not (fully) developed [(7)].

Brain MRI can aid to improve the accuracy and confidence about the diagnosis, which is relevant for treatment decision making. It also important for prognosis estimation and to exclude other possible and sometimes treatable causes of parkinsonism [(8)].

Furthermore, brain MRI can support the possible or probable diagnosis of aspecific form of AP [(9)].

Conclusion and Recommendation

Conventional MRI play an important role in differentiation of typical parkinsonism (PD) from atypical parkinsonism (PSP, MSA and CBD) which is difficult in diagnosing by cilinical examination especially in early stages.

In this study we had 40 patients clinical diagnosed as parkinsonism. All patients underwent conventinal MRI with high resolution, only 9 patients (22.5%) had positive radiological findings of atypical parkinsonism as follow; 4 patients (44.4%) had radiological signs of PSP, 5 patients (55.6%) had radiological findings of CBD and 31patients (77.5%) of typical parkinsonism, only 3 patients (9.7%) had radiological findings of PD and the remaining 28 patients (90.3%) seen radiologically normal.

For more accurate and early diagnosing of different types of parkinsonism we recommend more advanced techniques such as MRI 3T, functional MRI, DTI, PET and SPECT scan.

References

1. Wilms H, Zecca L, Rosenstiel P, Sievers J, Deuschl G, Lucius R: Inflammation in Parkinson's diseases and other neurode-generative diseases: cause and therapeutic implications. Curr Pharm Des. 2007,13: 1925.
2. Gupta AJ, Dawson VL, Dawson TM. What causes cell death in Parkinson's disease? Ann Neurol.2008;64 S3–S15.
3. McNeill A, Birchall D, Hayflick SJ, Gregory A, Schenk JF, Zimmerman EA, Shang H, Miyajima H, Chinnery PF. T2* and FSE MRI distinguishes four subtypes of neurodegeneration with brain iron accumulation. Neurology. 2008; 70:1614.
4. Donald G. Mitchell MD, Mark Cohen Ph. Hardcover: 416 pages; Publisher:Saunders; 2 edition (December 5, 2003) ...ISBN-10: 0721600247; ISBN-13: 978.
5. Osborn AG, Blaser SI, Salzman KL, Katzman GL, Provenzale J, Castillo M, Hedlund GL, Illner A, Harnsberger HR, Cooper JA, Blaise VJ, Hamilton BE (2004) Diagnostic Imaging Brain. Salt Lake City, Utah: Amyrsis p I,8:59; I,8:67; I,8:70-73 [2] Spinner MA, Paulin HN, Wester CW (2012).
6. Parkinson’s Disease. NIH Publication No. 15-139. Dec 2014. National Institute of Neurological Disorders and Stroke, National Institutes of Health. Reeve A, Simcox E, Turnbull D. Ageing and Parkinson’s disease: why is advancing age the biggest risk factor? Ageing Res. Rev., 2014 Mar;14(100):19–30
7. Aerts MB, Meijer FJ, Verbeek MM, Esselink RA, & Bloem BR Diagnostic challenges in parkinsonism. (2011)Expert Rev Neurother, 11, 1099-1101.
8. Berg D, Postuma RB, Adler CH, Bloem BR, Chan P, Dubois B, Gasser T, Goetz CG, Halliday G, Joseph L, Lang AE, Liepelt- Scarfone I, Litvan I, Marek K, Obeso J, Oertel W, Olanow CW, Poewe W, Stern M, &DeuschlG MDS research criteria for prodromal Parkinson’s disease. (2015) MovDisord, 30, 1600-1611.
9. Kirsty Bhattacharya, Daniela Saadia, MD; Barbara Eisenkraft, MD; Melvin Yahr. JAMA Neurology 59(5):835-42.June 2002.