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Dr. Venu Madhav Muppavarapu
Associate Professor,
Department of Radiology,
MNR Medical College and
Hospital, Sangareddy,
Telangana, India

Dr. Koppula Jagannath Reddy
Professor, Department of
Radiology, MNR Medical
College and Hospital,
Sangareddy, Telangana,
India

Evaluation of mesencephalic diameter using MRI in the diagnostic differentiation of progressive supranuclear palsy (PSP) from parkinson disease (PD)

Dr. Venu Madhav Muppavarapu and Dr. Koppula Jagannath Reddy

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Abstract

Diagnostic differentiation of progressive supranuclear palsy (PSP) from Parkinsons disease (PD) is difficult task in early stages. MR image based diagnosis plays a vital role in differentiation of parkinsonian syndromes because of its effective depiction of tissue anatomy. This study was designed to evaluate mesencephalic diameter using MRI in the differentiation of PSP from PD. A total 40 cases (20 cases clinically diagnosed with PSP and 20 cases with PD) and 20 healthy control subjects> 45 years were included. Cases were undergone with MRI (SEIMENS 1.5 Tesla) to detect antero-posterior diameter and superior profile of midbrain, tegmental hyper intensity, putamen intensity, Middle cerebellar peduncle width. AP diameter of midbrain was < 15mm in all the PSP cases, but none of the PD cases and control subjects. It has 100% sensitivity and specificity in differentiating PSP from PD and control subjects. The abnormal superior profile has 81% sensitivity, 80% specificity and 88% accuracy in identification of PSP from PD and control subjects. The measurement of mesencephalic diameter on standard routine T2 W MR images can be accurate to differentiate PSP cases from PD cases. Including this simple measure in the diagnostic criteria of PSP give effective outcome.

Keywords: Progressive supranuclear palsy (PSP), parkinson disease (PD), anteroposterior diameter of midbrain, middle cerebellar peduncle, magnetic resonance imaging

Introduction

Progressive supranuclear palsy (PSP) is an adult onset neuro degenerative disorder characterized by neuronal degeneration, tegmental loss in midbrain, changes in globus pallidus and red nucleus andatrophy of substantia nigra. In early stages, diagnostic differentition is difficult with Parkinson's disease. Differential diagnosis among PSP and PD is important because of its poor prognosis [1-3].

Error free clinical differentiation of PSP and PD may be difficult, especially in the early stages of the disease. MRI brain studies on PSP emphasized the utility of mid-sagittal MRI in its diagnosis. The range of midbarin area, pontine area and midbrain pons ratio was lower in PSP as compared to PD [4]. MRI based investigations of Progressive supranuclear palsy have shown abnormalities mainly involving the midbrain; such changes include atrophy, abnormal T2 hyperintensity in the tegmentum, and narrowing of the substantianigra. However, the introduction of MR imaging into the routine workup of patients with suspected Progressive supranuclear palsy or other parkisonian syndromes has been hampered by its low sensitivity and poor specificity and also by high variability, which can be heavily influenced by the neuroradiologist's experience [5].

This study was designed to evaluate mesencephalic diameter using standard routine T2 W MR images, which is useful in the differential diagnosis of PSP and PD.

Materials and Methods

The present study was conducted in the department of Radiology, MNR Medical College and Hospital, Sangareddy during April 2017 to June 2019. A total 40 cases, include 20 cases clinically diagnosed with progressive supranuclear palsy (PSP) and 20 cases clinically diagnosedwith PD diagnosed and 20 healthy control subjects referred by Neurology department, a speciality clinic run weekly once in the MNRMCH were recruited. Helathy control subjects were age matched and had normal findings in neurological examination.

Corresponding Author
Dr. Koppula Jagannath Reddy
Professor, Department of
Radiology, MNR Medical
College and Hospital,
Sangareddy, Telangana,
India

Cases with normal CT, belong to the age group>45 years and diagnosed with Parkinson's disease and progressive supranuclear palsy were included and cases with <45 years age, contraindications in MR were excluded from the study. Informed consent was obtained from all the cases and study protocol was approved by Institutional ethics committee. Clinical history of the patient was noted and all the cases were undergone to the baseline CT brain.

Study participants were undergone with MRI (SEIMENS 1.5 Tesla) to detect antero-posterior diameter and superior profile of midbrain, tegmental hyper intensity, putamen intensity, Middle cerebellar peduncle width. AP diameter of midbrain was assessed by Kruskall wallis test, followed by Mann Whitney U test for bonferroni correction. Collected Images were interpretated by the experienced radiologist. The AP diameter of midbrain was measured in T2WI axial images at rednucleus level, Superior profile of midbrain was measured by T2 WI mid saggital SPGR (Normal –convex, Abnormal -concave), Middle cerebellar peduncle (MCP) width measured in T1 WI para sagital SPGR and Tegmental intensity in assessed T2 WI axial images. Statistical analysis was done with SPSS for windows version. MRI measurements were assessed by Kruskall wallis test, followed by Mann Whitney U test for bonferroni correction.

Results

Table 1: Demographic parameters in study participants.

Parameters	Parkinson's disease	Progressive supranuclear palsy	Control subjects	P-value
Age at evaluate on (In yrs) mean±SD)	60.8±2.9	61.4±4.2	61.7±3.3	0.422
Sex				
Male	09 (50%)	10 (50%)	10 (50%)	0.218
Female	11 (50%)	10 (50%)	10 (50%)	
Onset of disease	56.8 years	57 years	-	0.364
Duration of disease	3.47 years	3.14 years	-	0.236

Gender differentiation (P=0.218), age (P=0.422), age onset of disease (P=0.364) and duration of disease(P=0.236)is not statistically significant (Table 1). The mean AP diameter of midbrain was low in PSP (1.20±0.68) than PD (1.68±0.26) and control subjects (1.76±0.95). The mean AP diameter of midnrain was statistically significant in PSP than PDand control subjects (Table 2).

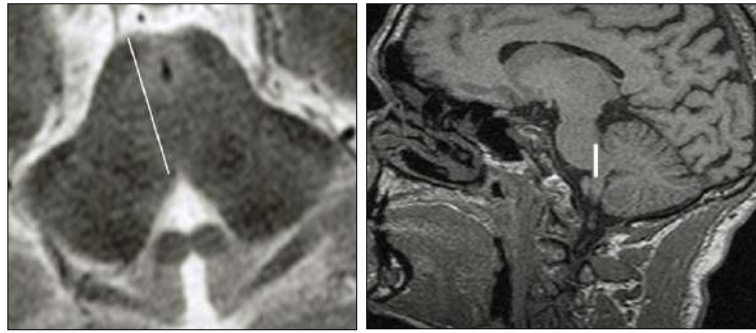**Table 2:** AP diameter of midbrain and width of MCP among study participants.

Parameters	Parkinson's disease	Progressive supranuclear palsy	Control subjects
Antero-posterior diameter of Midbrain (In cm)			
Maximum	1.79	1.29	1.84
Minimum	1.56	1.11	1.68
Mean± SD	1.68±0.26	1.20±0.68	1.76±0.95
P-value	0.003*		
Width of Middle cerebellar peduncle (In cm)			
Maximum	1.0	1.2	1.05
Minimum	0.90	0.89	0.90
Mean± SD	0.95±0.11	0.96±0.11	0.98±0.16

**Table 3:** Details of various study parameters among study participants.

Parameters	AP diameter of Midbrain (<15mm)	Abnormal upper profile of Midbrain	Tegmental & putamen hyper intensity
Parkinson's disease (n=20)	00	13	NIL
Progressive supranuclear palsy (n=20)	20	07	05
Control subjects (n=20)	NIL	NIL	NIL

Table 3: Sensitivity and specificity of parametersin differentiate study participants.

Statistical values	AP diameter of Midbrain (<15mm)	Abnormal upper profile of Midbrain	Tegmental & putamen hyper intensity
Sensitivity	100%	81%	32%
Specificity	100%	80%	99%
Positive Predictive value (PPV)	100%	72%	98%
Negative predictive value (NPV)	100%	87%	79%
Accuracy	100%	88%	93%

Fig 1: MR images showing AP diameter of midbrain and width of middle cerebellar peduncle among study participants.
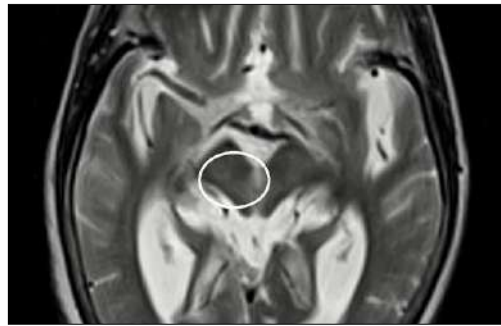
Fig 2: MR image showing tegmental hyper intensity of study participants.

Discussion

MR imaging based measurement of brainstem diameter is ideal to differentiate various brain disorders. Measuring anteroposterior diameter of midbrain may differentiate cases with PSP from with PD [6]. This study was conducted to evaluate the anteroposterior diameter of midbrain and other associated parameters on routine MR images to differentiate Parkinson'sdisease with progressive supranuclear palsyin comparison with age matched healthy subjects. A total 40 cases (20 PSP, 20 PD) and 20 age matched healthy subjects with >45 years of age were selected. There is no statistical difference in gender, onset of disease and mean duration of disease among the study groups.

The mean width of middle cerebellar peduncle (MCP) in PD cases was 0.95±0.11, in PSP cases 0.96±0.11 and in healthy subjects 0.98±0.16. Waseem Mehmood *et al*., found that the mean width of MCP in PSP was 12.78mm, it is smaller than those of PD (12.81mm) and healthy subjects (13.4mm). the study outcome was comparable with other studies [7-10].

In this study, <15mm of AP diameter of midbrain was considered as progressive supranuclear palsy. AP diameter of midbrain was < 15mm in all the PSP cases, but none of the PD cases and control subjects have AP diameter <15mm. AP diameter of midbrain has 100% sensitivity and specificity in differentiating PSP from PD and control subjects. Andrea Righini *et al*., in their study found that average AP diameter of midbrain was smaller in PSP group than PD group but observed an overlap [11]. Warmuth-Metz *et al*., and Schrag *et al*., found significant decrease in the AP diameter of midbrain in PSP cases [12, 13] Study by Emam AT *et al* stated that ranges of pons, midbrain and midbrain pons ratio was lower in PSP as compared to PD [14]. Oba H *et al*., stated that midbrain area <70mm was referred as PSP, whereas midbrainpons ratio <0.15 excludes the diagnosis of PD [15].

Concave and flat superior profile of midbrain considered as abnormal i.e. progressive supranuclear palsy. The abnormal superior profile was seen in 13 cases with PD and 7 cases with PSP. It has 81% sensitivity, 80% specificity and 88% accuracy in identification of PSP from PD and control subjects. Andrea Righini *et al*., in their study found abonormal superior profile of midbrain had 68% sensitivity and 88.8% specificity [16]. The flattening and concavity of the superior profile of midbrain is related to focal parenchymal loss, which accompany with global atrophy of whole midbrain. Histological studies on midbrain confirmed the heavy neuronal loss in the preaqueductal gray matter, cuneiform nucleus, pretectal area and Edinger-Westphal nucleus, Above mentioned structure are lies in cranial and caudal portion of midbrain and their atrophy explains decreasing in thickness and loss of convex profile of midbrain [16] Tegmental hyper intensity was seen in 5 cases with PSP, but none of the case was found in PD and control group. It has 32% sensitivity and 99% specificity in differentiating PSP from PD and control subjects. Andrea Righini *et al*., in their study found 28% sensitivity and 100% specificity [11].

Conclusion

MRI plays a vital role in differentiation of parkinsonian syndromes because of its effective depiction of tissue anatomy. The study results concluding that NO significant difference in Age at onset and Mean duration of disease, in PSP and PD groups. AT the level of red nucleus measurement of AP diameter of midbrain in T2 WI axial images is an accurate procedure to differentiate PSP from PD. AP diameter of midbrain was < 15mm in all the PSP cases, but none of the PD cases and control subjects have AP diameter <15mm. AP diameter of midbrain has 100% sensitivity and specificity in differentiating PSP from PD and control subjects. No PSP cases had mean width of MCP <8mm.The measurement of mesencephalic diameter on standard routine T2 W MR images can be accurate to differentiate PSP cases from PD cases. Including this simple measure in the diagnostic criteria of PSP give effective outcome.

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