ORIGINAL ARTICLE

EFFECT OF AGEING IN PAKISTANI POPULATION ON MIDBRAIN TO PONS AREA RATIO USING MRI: A RETROSPECTIVE STUDY

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ABSTRACT

INTRODUCTION: Normal aging results in brainstem atrophy. In making diagnosis of Progressive Supranuclear Palsy (PSP) and other Parkinson s s disease spectrums, midbrain-pons ratio has been utilized as a radiological indicator. **AIM:** To estimate the ratio and size of the midbrain and pons areas in the adult and elderly populations of Pakistan. This is because no study is available till date. **MATERIALS AND METHODS:** This cross-sectional, analytical study was done in Shifa International Hospital, Islamabad, Pakistan, from January 2023 to March 2023 in which midbrain area and pons area was calculated and their ratio were taken with respect to age an gender. **RESULTS:** Reduction in midbrain to pons ratio was seen with increasing age, normal aging process. **CONCLUSION:** When evaluating the findings, age must be considered because the midbrain to pons area ratio decreases considerably with age.

Keywords: Midbrain, Pons, Ratio, PSP, Radiology

Introduction

PSP, MSA, and Corticobasal Ganglionic Degeneration (CBGD) are among the neurological illnesses that make up Parkinson plus syndrome. Each condition's diagnosis is crucial since it has an impact on the treatment, recovery, and prognosis of the patient. Although it varies from typical PD in terms of clinical characteristics and responsiveness to levodopa, clinical diagnosis might be difficult in the early stages of the illness.[1] The midbrain atrophy with dilated third ventricle, decreased midbrain anteroposterior diameter (17 mm), flattening/concavity of the superior midbrain, and atrophy of tegmentum on axial sections (Morning glory sign) are the defining MRI findings in PSP. The mickey-mouse sign appears on the axial pictures when the anteroposterior midbrain is reduced at the level of the superior colliculi. The hummingbird sign, also known as the penguin sign, is caused by midbrain atrophy and pons preservation. The pons depicts the body of the hummingbird/penguin, whereas the tegmentum symbolizes the head with a narrow beak. Atrophy and Fluid Attenuated Inversion Recovery (FLAIR) hyper intensity of the superior cerebellar peduncles are further imaging characteristics. These distinguishing characteristics aid in separating PSP from Parkinsonism and MSA.[2]

Material and Methods

Type: Cross sectional study

Place and time: Shifa International Hospital, Islamabad, Pakistan. January 2023 to March 2023.

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MRI acquisition and measurement

T1-weighted sagittal images, T1-weighted axial images, and FLAIR axial images were obtained using 1.5 and 3-T MRI scanners. Manual measurements were taken using a midsagittal TI-weighted MRI. On T1 weighted midsagittal images, the brainstem was divided into three sub-regions (midbrain, pons, and medulla oblongata) by drawing two cutting planes: the first between the superior pontine notch and the inferior edge of the quadrigeminal plate (line 1) and the second parallel to the first through the inferior pontine notch (line 2). The midbrain (excluding the tectum) was located above line 1. The pons region is located between the two previously stated lines. The midbrain to pons area ratio was established by dividing the midbrain area by the pons area.[3]

Sample size calculation:

Sample size was calculated by usingthe method for comparing means.

$N=2(Z\alpha/2\text{-}Z\ )\ 2\ \sigma 2\ /d2$[4]

where sample size is N, constants are $Z\alpha/2$ and Z and for confidence level 95% and power of 80% they are 1.96 and 0.84 respectively, s is population standard deviation (0.15- based on pilot study) and difference in mean values expected is d. The value obtained was approximately 160 after catering for all the study variables. Hence, a final sample size of atleast 200 was considered for final analysis. These were divided according to age and gender.

Overall four groups consisting of approximately 50 participants each were selected for the study and designated as:

M1 (Male between 18 to 50 years)
M2 (Males>50 years)
F1 (Females between 18 to 50 years)
F2 (Females > 50 years).

Inclusion criteria:

Patients who presented to the Radiology Department for causes such as headache, sleeplessness, abdominal discomfort, gynecological issues, and so on that were unlikely to affect and involve the brainstem were evaluated for inclusion.

Exclusion criteria:

Patients with dementia (as defined by the Diagnostic and Statistical Manual of Mental Disorders- DSM 5 criteria), Parkinson's disease, and plus syndromes such as PSP and Multiple System Atrophy (MSA) were excluded from the research. Participants who had organic intracranial abnormalities seen on MRI were also eliminated.

Although certain features help to distinguish PSP from other clinical diagnoses (Parkinson's disease and multiple system atrophy, for example), it should be noted that, except in classic cases, imaging features are usually suggestive rather than pathognomonic, due to overlap with other conditions. Midbrain atrophy, the MR Parkinsonism Index (MRPI), and a decreased area ratio on the midline sagittal plane to roughly 0.12 are MRI findings. The most accurate imaging characteristic, which also aids in distinguishing it from multiple system atrophy parkinsonian type (MSA-P) (which exhibits pontine and midbrain atrophy)[5]

Our Ground Reality:

Our study includes 210 apparently healthy adult and elderly participants. Divided amongst two groups, 107 men (M1 ≤50 years and M2 >50 years) and 103 women (F1 ≤50 years and F2 >50 years).

Each had a multiplanar T1 Magnetic Resonance Imaging (MRI) of the brain performed. Radiologists with experience detected the mid-sagittal images and assessed the midbrain and pons regions on that image. The mean and standard deviations of midbrain and pons area, as well as the midbrain to pons area ratio, were calculated for each group. To examine the significance of differences between groups, the Independent Sample t-test was performed.

Results

A total of 210 participants were included in the study with mean age of 48 years and 1 months. Midbrain to pons ratio in less than 50 years of age (M1 and F1) had a mean of 0.3117 with Std. deviation of 0.04884. Midbrain to pons ratio in greater than 50 years of age (M2 and F2) had a mean of 0.2572 with Std. deviation of 0.03889.

Descriptives Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age (less Than 50 year of age)	103	18.00	50.00	29.9903	12.39979
Gender (less Than 50 year of age)	103	1	2	1.51	.502
Area of Midbrain (less Than 50 year of age)	103	105.0	220.0	147.699	23.5109
Area of pons (less Than 50 year of age)	103	292.0	634.0	469.126	57.7458
Midbrain to pons ratio (less Than 50 year of age)	103	.20	.43	.3117	.04884
Age (greater Than 50 year of age)	107	51.00	91.00	65.6449	9.82608
Gender (greater Than 50 year of age)	107	1	2	1.47	.501
Area of Midbrain (greater Than 50 year of age)	107	78.0	193.0	127.031	21.3272
Area of pons (greater Than 50 year of age)	107	358.0	625.0	486.252	58.7438
Midbrain to pons ratio (greater Than 50 year of age)	107	.15	.35	.2572	.03889

Table 1:

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Midbrain to pons ratio	Less Than 50 years of Age	103	.3117	.04884	.00481
	Greater Than % 50 years of Age	107	.2572	.03889	.00376

Table 2:

Independent Samples Test										
		Levene's Test for Euqality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Midbrain to pons ratio	Equal variances assumed	5.394	.021	8.971	208	.000	.05455	.00608	.04256	.06654
	Equal variances not assumed			8.933	194.726	.000	.05455	.00611	.04251	.06660

Table 3:

Groups	Age Range (Mean ± SD)	Gender	Number of Participants	Area of Midbrain (Mean ± SD)	Area of Pons (Mean ± SD)	Midbrain to pons Area ratio (Mean ± SD)
M1	18-50 years (29.1 ± 13.2)	Males	50	(143 ± 26.2)	(481 ± 65.17)	(0.29 ± 0.04)
M2	51-89 years (67.42 ± 10.4)	Males	57	(129 ± 21.9)	(504 ± 62.4)	(0.25 ± 0.04)
F1	18-50 years (30.8 ± 11.5)	Females	50	(152 ± 19.8)	(458 ± 47.6)	(0.32 ± 0.04)
F2	51-91 years (63.6 ± 8.78)	Females	53	(124 ± 20.6)	(461 ± 46)	(0.26 ± 0.04)
(M1+M2)	18-89 Years (49.51 ± 22.5)	Males	107	(135.7 ± 24.8)	(493.7 ± 64.5)	(0.27 ± 0.05)
(F1+F2)	18-91 years (46.75 ± 19.41)	Females	103	(138.7 ± 24.5)	(461.4 ± 47.0)	(0.30 ± 0.05)
All	18-91 Years (48.1 ± 21.05)	Both	210	(137 ± 24.6)	(477 ± 58.7)	(0.28 ± 0.05)

Table 4:

Comparison groups	Midbrain Area P-Value	Pons Area P-Value	Midbrain to Pons area Ratio P-Value
M1 and M2	.001	.000	.000
F1 and F2	0.06	0.17	0.007
M1 and F1	0.021	0.021	0.00
M2 and F2	0.10	0.013	0.02
Males and Females	0.19	0.038	0.045

Table 5:

Discussion

Morelli M et al. discovered that the mean midbrain and pons areas in mid-sagittal images were 142 and 528 sq mm in the control group.[6] The mean midbrain and pons areas in mid-sagittal images were 145 and 511 sq mm, respectively, among apparently normal controls, according to Rajagopal KV et al.,[7] which are similar to the values reported by Tukaram R et al. (139 and 440 sq mm, respectively, among control group)[8] (Although the midbrain size (147 sq mm) acquired in the current investigation is similar to the cited studies, the pons area values (469 sq mm) obtained were lower. The variety of participant age groups and the higher sample size in the current research might be valid explanations. The midbrain to pons area ratios found by Rajagopal KV et al., (0.28), Morelli M et al., (0.27), and Tukaram R et al., (0.32) in control groups agree with the current study (0.3117).[6,7,8]

The lower value of the midbrain to pons area ratio among the elderly was owing to considerably reduced midbrain size, while pons sizes were comparable across all groups. This implies that even in the absence of Parkinson's, PSP, or MSA, there is midbrain atrophy with near normal pons, albeit the level of midbrain atrophy may be severe in the latter disorders, as shown by low midbrain to pons ratios. Morelli M et al. discovered values in the 0.13-0.23 range, but Oba H et al. discovered ratios smaller than 0.16 in PSP.[5,6] Tukaram R et al. discovered values close to 0.20 in a small group of seemingly healthy older people.[8] Our values were likewise comparable, with a mean of 0.2572 and a standard deviation of 0.03889. As a result, age is a key component to consider whenever the ratio is interpreted.

Conclusion

The midbrain to pons area ratio declines dramatically with age, hence age must be considered when interpreting the data. The lower ratio is due to severe midbrain thinning and a near normal pons.

References

1. Quattrone A, Morelli M, Williams DR, Vescio B, Arabia G, Nigro S, et al. MR parkinsonism index predicts vertical supranuclear gaze palsy in patients withPSP-parkinsonism, aldoquattrone. Neurology. 2016; **87(12):** 1266-73.

2. Kataoka H, Tonomura Y, Taoka T, Ueno S. Signal changes of superiorcerebellarpeduncle on fluid-attenuated inversion recovery in progressive supranuclear palsy. Parkinsonism RelatDisord. 2008; **14(1):** 63-5.

3. Cui SS, Ling HW, Du JJ, Lin YQ, Pan J, Zhou HY, Wang G, Wang Y, Xiao Q, Liu J, Tan YY. Midbrain/pons area ratio and clinical features predict the prognosis of progressive supranuclear palsy. BMC neurology. Dec 2020; **20(1):** 1-7.

4. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013; **35(2):** 121-6.

5. Oba H, Yagishita A, Terada H et al. New and Reliable MRI Diagnosis for Progressive Supranuclear Palsy. Neurology. 2005; **64(12):** 2050-5.

6. Morelli M, Arabia G, Messina D, Vescio B, Salsone M, Chiriaco C, et al. Effect of aging on magnetic resonance measures differentiating progressive supranuclear palsy from Parkinson s disease. Mov Disord. 2014; **29(4):** 488-95.

7. Rajagopal KV, D Souza AS, Verma A, Mamatha H, Prasanna LC. Comparative morphometric evaluation of the brainstem in neurodegenerative diseases with healthy individuals using magnetic

resonance imaging. J Taibah Univ Med Sci. 2021; **17(1):** 87-95.

8. Tukaram Rathod, KS Sachin, Upendra Kumar Joish, S Vishnupriya, GM Vinutha. Effect of Ageing on Midbrain to Pons Area Ratio using MRI: A Cross-sectional Study. IJARS 2022; **11(4)**.