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Study of the normal interpeduncular angle range and gross dimensions of the brain across different age groups in the South Indian population

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Abstract

Background: The interpeduncular angle in the brain is defined as the angle formed by the medial margins of the posterior half of the cerebral peduncles on axial MRI brain images. Our study was aimed to assess the normal interpeduncular angle, ponto-mamillary distance and maximum AP and lateral diameters of the brain across various age groups in the Indian population & to establish reference values for the same which may aid in clinical diagnosis.
Material and Methods: The study was a single-center, retrospective, observational study. The brain MRI studies for patients with non-specific complaints over a 6 month period were included in the study.
Results: 400 cases (50 cases were included per decade from 10 to 90 years age groups) were studied. The maximum lateral dimensions of the brain appear to slightly decrease with each decade of life as expected however the maximum AP diameter was relatively constant. The ponto-mamillary distance showed no specific trend and remained relatively constant across all the age groups. The inter-observer variation was good for the interpeduncular angle, pontomamillary distance, maximum lateral and AP diameters of the brain.
Conclusion: The interpeduncular angle was found to slightly increase with each decade of life. The maximum lateral dimensions of the brain appear to slightly decrease with each decade of life as expected however the maximum AP diameter was relatively constant.

Keywords: Interpeduncular angle, pontomamillary distance, MRI brain, intracranial hypotension

Introduction

The interpeduncular angle in the brain, defined as the angle formed by the medial margins of the posterior half of the cerebral peduncles on axial images, has been described as a practical and simple useful technique on MRI brain to aid in the diagnosis of neurological conditions such a benign intracranial hypotension(reduced) and neurodegenerative disorders like PSP (increased) [1, 2].
Intracranial hypotension (IH) is an uncommon, benign, and usually self-limiting condition caused by low cerebrospinal fluid (CSF) pressure, usually due to CSF leakage. The dominant clinical finding is an orthostatic headache. Other common clinical features include fever,

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nausea, vomiting and tinnitus [3]. Because IH can occur with normal CSF pressure and symptoms can exacerbate after lumbar puncture, clinicians and radiologists should be aware of characteristic MRI features of IH such as diffuse intracranial pachymeningeal enhancement, sagging of the brain, pituitary enlargement, subdural fluid collections (usually hygromas, less likely hematomas), posterior lobe pituitary hematomas, diffuse dural enhancement of the spinal canal and spinal epidural fluid collections [4].
The interpeduncular angle is an objective, reproducible measure on brain MR imaging that is sensitive and specific for intracranial hypotension in adults. It is easily measured on axial T2-weighted sequences and can be practically incorporated into routine search patterns [5]. However currently there is no described reference range for the normal interpeduncular angle in the normal population. Present study was aimed to assess the normal interpeduncular angle, ponto-mamillary distance and maximum AP and lateral diameters of the brain across various age groups in the Indian population & to establish reference values for the same which may aid in clinical diagnosis.

Material and Methods

Present study was a single-center, retrospective, observational study, conducted in department of radiodiagnosis in a tertiary care hospital in South India. Study approval was obtained from institutional ethical committee.
Consecutive relatively normal brain MRI studies for patients with non-specific complaints over a 6 month period were included in the study. The presence of significant positive brain findings not explained by age alone (like tumors, hemorrhage, raised intracranial pressure), clinical data with headache, movement disorders were excluded from the study.
The mamillo-pontine distance and the maximum AP diameter of the brain were measured on the midsagittal T1W sagittal images and the interpeduncular angle and the maximum lateral dimension of the brain was measured on the on the axial T2W images. Two radiologists were involved in calculating the above measurements and the inter-observer variability was also assessed.
Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables. Statistical analysis was done using descriptive statistics.

Results

Around 1000 MRIs were reviewed totally and 600 were excluded as they did not meet the criteria.50 patients each from each decade of life (10-90 years) were analysed in groups and the parameters were measured and assessed. Most of these patients in the 70-90 age groups had chronic small vessel ischemic changes which is expected with age. The sample size was 400 cases (50 cases were included per decade from 10 to 90 years age groups).
The mean interpeduncular angle calculated was found to be 65.7 ± 2.946 and pontomedullary distance was 7.26 ± 0.398 mm. The interpeduncular angle was found to slightly increase with each decade of life.

Table 1: Gross dimensions of brain (IP angle & PM distance)

Age group	IP angle (Mean ± SD)	PM distance (Mean ± SD) (mm)
11-20 years	59.04 ± 8.2	8.08 ± 1.5
21-30 years	62.3 ± 7.8	6.85 ± 1.2
31-40 years	63.1 ± 7.1	6.8 ± 1.18
41-50 years	64 ± 7.6	7.01 ± 1.05
51-60 years	64.8 ± 7.01	6.72 ± 1.2

61-70 years	70.48 ± 6.5	6.84 ± 1.17
71-80 years	71.36 ± 7.2	7.6 ± 1.25
81-90 years	70.53 ± 8.6	8.23 ± 1.38
Mean ± SD	65.7 ± 2.946	7.26 ± 0.398

In the present study, maximum lateral dimension was 119.8 ± 1.403 mm and the maximum AP diameter was 155.74 ± 0.84 mm.

The maximum lateral dimensions of the brain appear to slightly decrease with each decade of life as expected however the maximum AP diameter was relatively constant. The ponto-mamillary distance showed no specific trend and remained relatively constant across all the age groups.

The inter-observer variation was good for the interpeduncular angle, pontomamillary distance, maximum lateral and AP diameters.

Table 2: Gross dimensions of brain (Max Lateral Diameter & Max AP Diameter)

Age group	Max Lateral Diameter (Mean ± SD) (mm)	Max AP Diameter (Mean ± SD) (mm)
11-20 years	124.6 ± 5.55	156.36 ± 7.3
21-30 years	121.14 ± 6.67	155.18 ± 6.047
31-40 years	119.66 ± 5.69	153.08 ± 6.44
41-50 years	119.32 ± 5.09	154.92 ± 6.71
51-60 years	119.2 ± 4.47	157.18 ± 6.25
61-70 years	118.58 ± 4.6	156.25 ± 7.35
71-80 years	118.9 ± 5.03	156.6 ± 6.8
81-90 years	117.54 ± 5.88	156.41 ± 5.83
Mean ± SD	119.8 ± 1.403	155.74 ± 0.848

Discussion

Intracranial hypotension is a neurologic syndrome with various etiologies that share a common final pathway of decreased CSF volume and pressure [5]. More recently, the etiology for spontaneous intracranial hypotension (SIH) attributed to CSF leaks due to osteo discogenic microspurs, rupture of spinal nerve root diverticula or more controversially, CSF-venous fistulae [6, 7].

X D.J. Wang *et al*., [2] studied brain MRIs of 30 patients with intracranial hypotension and 30 age-matched controls for classic findings of intracranial hypotension and the interpeduncular angle. The interpeduncular angle had excellent inter-observer reliability (intraclass correlation coefficient value =0.833) and was significantly lower in the intracranial hypotension group compared with the control group (25.3° versus 56.3°; P <0.001). There was significant correlation between the interpeduncular angle and the presence of brain stem slumping (P <0.001) and in cases with ≥ 3 classic features of intracranial hypotension (P <0.01). With a threshold of 40.5°, sensitivity and specificity were 80% and 96.7%, respectively. The interpeduncular angle is a sensitive and specific measure of intracranial hypotension and is a reliably reproducible parameter on routine clinical MR imaging.

In the setting of progressive supranuclear palsy, a threshold of 57° yielded a sensitivity of 100% and specificity of 90% in distinguishing these patients from those with Parkinson disease and multiple system atrophy Parkinsonian subtype [1].

Shah LM *et al*., [8] studied 29 patients with intracranial hypotension, the mean mamillopontine distance, and lateral ventricular angle was 4.4 mm (SD, ± 1.8), and 130.1° (SD, ± 9.8°), respectively. In the control group, the mean mamillopontine distance, and lateral ventricular angle were 7.0 mm (SD, ± 1.3) and 132.2° (SD, ± 5.7°), respectively. The differences in the mamillopontine distance values for the intracranial hypotension group versus the control group were statistically significant (p < 0.01). The difference in the lateral

ventricular angle measurements was not statistically significant (p = 0.37). Cutoff points of a 5.5-mm mamillopontine distance was estimated using receiver operating characteristic curves.

In another study by Ugga L. *et al*., [9] noted that interpeduncular angle (IPA) was generally higher in idiopathic normal pressure hydrocephalus (iNPH) than in progressive supranuclear palsy (PSP) patients and in healthy controls; therefore, it demonstrated a useful additional marker to differentiate this potentially treatable condition.

Uzuner, M. B *et al*., [10] divided patient population into 4 categories as non-specific headache (thought to be of the tension-type), vasovagal syncope, sinusitis and epilepsy. The population average age in this series was 11.05 ± 3.78 (range, 5 to 17) years. The comparison of interpeduncular (IP) angle yielded statistically significant differences between tension-type headache-epilepsy, tension type-headache-vasovagal syncope, epilepsy-control and vasovagal syncope-control groups.

Sohmiya M *et al*., [11] noted that, age was negatively correlated with the maximum anteroposterior distance of the midbrain through the substantia nigra (MD) and the average distance from the substantia nigra to the red nucleus (SNRND), while a positive correlation was found between aging and the maximum distance of the substantia nigra (SND). Age-related structural changes of the midbrain may have a close relation to a decline in motor performance with aging. These findings provide essential information to evaluate the MR images of neurodegenerative disorders.

The interpeduncular angle in the brain has been described as a practical and simple useful technique on MRI brain to aid in the diagnosis of neurological conditions such as benign intracranial hypotension(reduced) and neurodegenerative disorders like PSP (increased). However currently there is no described reference range for the normal interpeduncular angle in the normal Indian population. Hence our results may help to establish normal ranges across different age groups which will be helpful for future reference while diagnosing these conditions. Indian brains have also been found on an average to have a smaller height, width and volume as compared to the Western and other eastern populations hence the other parameters calculated may help us compare this and establish normal ranges for the Indian population.

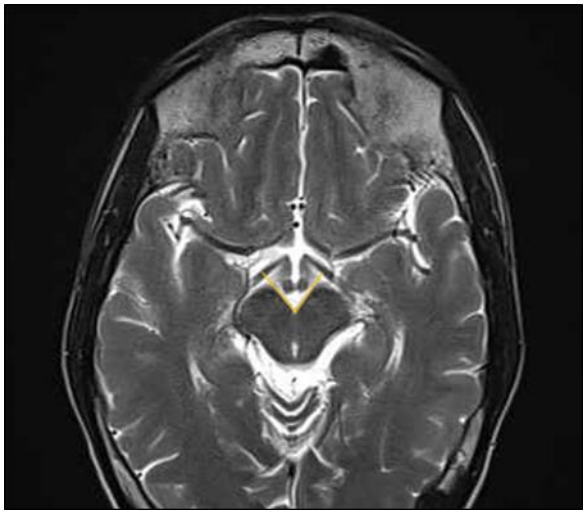

Fig 1: T2 axial section MRI Brain showing interpeduncular angle measurement at the level of the mamillary body

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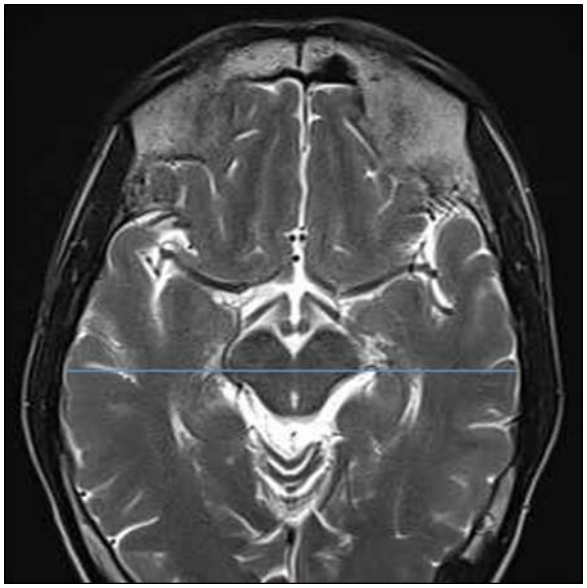

Fig 2: T2 Axial section MRI brain showing the maximum lateral dimension of the brain

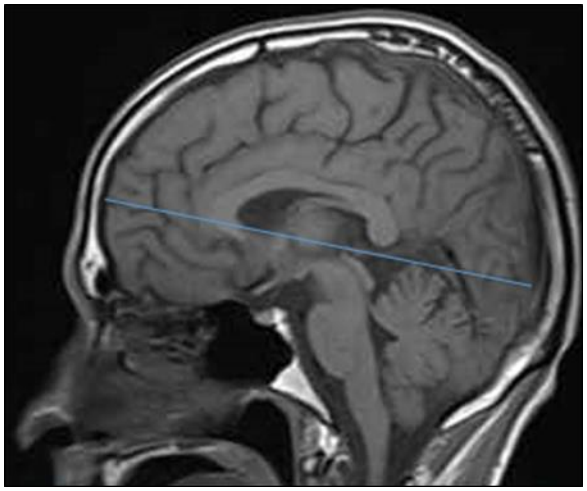

Fig 3: T1-sagittal section of MRI brain showing the measurement of the maximum AP diameter of the brain

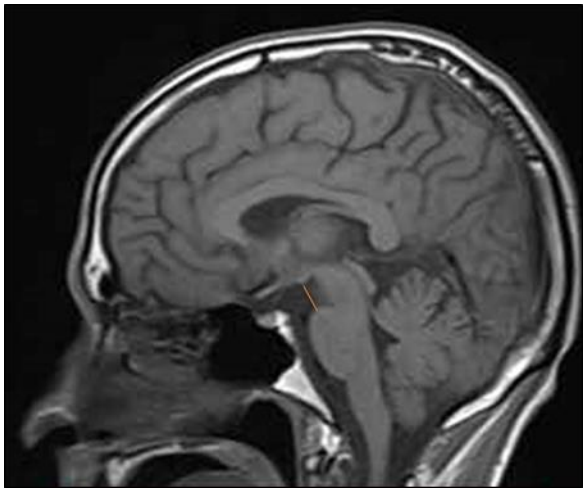

Fig 4: T1-sagittal section of MRI brain showing the measurement of the ponto-mamillary distance

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Conclusion

The interpeduncular angle was found to slightly increase with each decade of life. The maximum lateral dimensions of the brain appear to slightly decrease with each decade of life as expected however the maximum AP diameter was relatively constant. The pontomamillary distance showed no specific trend and remained relatively constant across all the age groups.

Conflict of interest: None to declare.

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