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Research Article

MORPHOMETRIC STUDY OF HIPPOCAMPUS IN ADULT HUMAN BRAINS

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ABSTRACT
Hippocampus is a component of limbic system associated with learning, memory and emotions, diseases resulting in the deficiencies in the process of above functions which could be a consequence of a change in the morphology induced by some pathology, hence to locate the pathology normal mophometric data is essential. In the present study Hippocampi which were dissected out from 50 adult male cadavers were subjected to morphometric evaluation to obtain the following mean values . Average adult cadaver age and weight of whole brain were 56.5 years, 1035.4gm respectively. The average values of right hippocampus were recorded as follows weight 4.11572 gm, length 6.996 cm, width 1.998,volume 13.978 and surface area11.839 cubic centimetre while left hippocampus mean values were weight 3.96458gms,length 6.995, width 1.998,volume 13.976 and surface area 11.713cc.There was no influence of weight on volume .

Key Words: *Hippocampus, Limbic System and Morphometric data.*

INTRODUCTION
Illustrative role can be attributed to Hippocampus in the process of learning and memory. Being an integral part of the functionally connoted Limbic part of brain, located in the inferior horn of the lateral ventricle hippocampus holds the most important share in the functioning of the limbic system. Anatomy of neocortical mantle encircling the base of the cerebral hemispheres was called as *Le grand lobe limbique* by Broca an eminent neuroanatomist to include subcallosal, cingulate and parahippocampal gyri along with hippocampus and dentate gyrus into this limbic lobe Gray's (1999) .
The constituents of Hippocampal formation as described by Henry gray are Hippocampus,Dentate gyrus , Subicular complex which is further differentiated into (subiculum presubiculum and parasubiculum) and entero rhinal cortex Gray's (1999). Amaral (1990) even indicated peri-rhinal cortex also as a component of this hippocampal formation. Papez (1929) described a closed circuit encompassing the hippocampus which on damage results in emotional disturbances in the individual.Talmage (1955) observed that hippocampus does not preserve memory but makes preservations of memory traces possible due to its internal structure as an equivalent to the serial component of computer system.
Hippocampus was supposed to be a constituent of olfactory centre directly continuing with the position of hippocampal gyrus known as subiculum and is formed by a primitive portion of cortex that has been rolled into the ventricle along the line of hippocampal fissure upon the ventricular surface a thin layer of white matter called alveus which in turn gives rise to the fibres that reach the fimbria and the fornix.
Structural change in the hippocampus is being assumed to be the principal cause for alzemeir's disease Lehericy(1994), schizophenia Gur (2000)and temporal lobe epilepsy Cendes (1993) latest non invasive diagnostic tools such as MRI need to be supported with adequate and appropriate anatomical knowledge hence the present study has been done.

MATERIALS AND METHODS
The present study was done on 50 adult brains obtained from the Anatomy and Forensic departments of AMC and KGH from 1999 to 2002. The adult cadaver ages ranged from 30 to 70 years only male were included. From the brains which were fixed by injecting sufficient quantity of 10% formalin into the cranial cavity of adult cadavers Hippocampus was isolated by careful removal of superior and middle

temporal gyrus of the temporal lobe of the brain to locate it along the floor of the inferior horn of the corresponding lateral ventricle.

The following encepalometric data was obtained after careful identification and isolation of hippocampus: weight, length, total width at pes hippocampus, surface area was calculated with the help of outline tracing technique and superimposing on graph paper and total volume was measured by water displacement method using $\pi r2h$. Weight of the adult brain without meninges was also included in the calculation of the above encephalometric indices.

Table 1: Morphometric study of hippocampus in adult human brains

S. No.	Age	Brain Wt In gms	HC Wt Right gms	HC Wt Left gms	HC Length Right cm	HC Length Left cm	Width At Pes Right Cm	Width At Pes Left cm	HC S.A Right cm	HC S.A Left Cm	HC volume Right cc	HC volume left cc
1.	30	880	4.178	4.170	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
2.	32	900	4.18	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
3.	35	900	4.18	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
4.	40	900	3.995	3..980	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.90
5.	40	1150	4.100	4.080	7.00	7.00	2.0	2.0	14.00	14.00	12.50	12..30
6.	42	1050	4.18	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
7.	44	1100	4.18	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
8.	45	1100	4.200	4.100	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
9.	45	1050	4.300	4.200	7.00	7.00	2.0	2.0	14.00	14.00	11.90	11.80
10.	47	1180	4.150	4.100	7.00	7.00	2.0	2.0	14.00	14.00	12.00	12.00
11.	48	1200	4.003	4.003	7.00	7.00	2.0	2.0	14.00	14.00	11.80	11.60
12.	48	1190	4.18	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
13.	49	1200	4.150	4.100	7.00	7.00	2.0	2.0	14.00	14.00	12.00	12.00
14.	50	1200	4.180	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
15.	52	1050	4.350	4.150	7.00	7.00	2.0	2.0	14.00	14.00	12.00	12.00
16.	52	1100	4.180	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	12.00
17.	53	1180	4.500	4.400	7.00	7.00	2.0	2.0	14.00	14.00	12.00	12.00
18.	54	1200	4.450	4.300	7.00	7.00	2.0	2.0	14.00	14.00	12.00	12.00
19.	54	1180	4.180	4.100	7.00	7.00	2.0	2.0	14.00	14.00	11.90	11.80
20.	55	1050	4.150	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
21.	56	1180	4.300	4.200	7.00	7.00	2.0	2.0	14.00	14.00	11.95	11.90
22.	57	1190	4.680	4.600	7.00	7.00	2.0	2.0	14.00	14.00	11.80	11.60
23.	57	930	4.000	3.900	7.00	7.00	2.0	2.0	14.00	14.00	11.80	11.70
24.	58	1150	4.150	4.100	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.90
25.	58	1190	4.680	4.600	7.00	7.00	2.0	2.0	14.00	14.00	11.80	11.60
26.	59	1040	4.125	4.050	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.80
27.	59	1150	4.300	4.350	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
28.	60	1000	4.000	3.800	7.00	7.00	2.0	2.0	14.00	14.00	11.50	11.40
29.	60	1050	4.100	4.076	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
30.	61	1100	4.180	4.176	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.90
31.	61	1150	4.300	4.350	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
32.	62	1020	4.000	3.850	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
33.	62	1090	4.000	3.900	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95

34.	63	1100	4.180	4.176	7.00	7.00	2.0	2.0	14.00	14.00	11.80	11.60
35.	64	1040	4.125	4.050	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.80
36.	64	1000	4.000	3.800	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.80
37.	65	890	3.800	3.750	6.80	6.75	1.9	1.9	12.90	12.80	11.50	11.20
38.	65	900	3.900	3.800	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
39.	66	950	4.000	3.950	7.00	7.00	2.0	2.0	14.00	14.00	11.90	11.75
40.	66	900	3.900	3.750	7.00	7.00	2.0	2.0	14.00	14.00	11.50	11.40
41.	67	890	3.900	3.850	7.00	7.00	2.0	2.0	14.00	14.00	11.20	11.00
42.	67	900	3.800	3.700	7.00	7.00	2.0	2.0	14.00	14.00	11.60	11.50
43.	67	900	3.900	3.800	7.00	7.00	2.0	2.0	14.00	14.00	12.00	11.95
44.	68	900	3.800	3.750	7.00	7.00	2.0	2.0	14.00	14.00	11.80	11.60
45.	68	870	3.800	3.600	7.00	7.00	2.0	2.0	14.00	14.00	11.80	11.50
46.	69	950	4.000	3.700	7.00	7.00	2.0	2.0	14.00	14.00	11.00	10.80
47.	69	900	4.100	4.000	7.00	7.00	2.0	2.0	14.00	14.00	11.50	11.40
48.	69	950	4.000	3.800	7.00	7.00	2.0	2.0	14.00	14.00	11.60	11.50
49.	70	860	4.000	3.990	7.00	7.00	2.0	2.0	14.00	14.00	11.00	10.50
50.	71	870	3.800	3.700	7.00	7.00	2.0	2.0	14.00	14.00	10.80	10.50

Table 2: Morphometric study of hippocampus in adult human brains

	Mean age Of cadaver In years	Mean weight Of brain In gm	Mean Weight Hippocampus In gm	Mean length Of hippocampus in cm	Mean width Of hippocampus in cm	Mean volume Of hippocampus in cc	Mean surface Area of hippocampus in cm2
Range	56.46 30-71	1035.4 870-1200	NA	NA	NA	NA	NA
Right Hippocampus Range	NA	NA	4.11572 3.8-4.68	6.996 6.8-7.0	1.998 1.9-2.0	11.839 10.8-12.50	13.978 12.9-14
Left Hippocampus Range	NA	NA	3.96458 3.6-4.6	6.995 6.75-7.0	1.998 1.9-2.0	11.713 10.50-12.3	13.976 12.8-14

Observations

The adult hippocampus present in the inferior horn of lateral ventricle measured about 7cm on the right side and a maximum of 7cm on left side of same brain. The minimum hippocampus length recorded on the right side was 6.8cm while of the left side as 6.75cm.The weight of the right hippocampus recorded a maximum of 4.68gms on the right side 4.6 on the left side. The minimum weight of right hippocampus was 3.8gm while on left side 3.75gms. The total weight of brain recorded is 1200 gms while the minimum weight of brain recorded is 860gms whereas the minimum weight of right and left hippocampi belong to two different specimen (Table 1**).**

The volume of hippocampus constitutes 0.33% of the total brain weight on an average as per the present study. The maximum width of the Pes hippocampus recorded on both sides was 2 cm. and the minimum

1.9cms of both sides. The surface area of hippocampus on right side constitutes 14 sq cms while a minimum of 12.9 sq.cms recorded (Table 1**).**
The volume of the hippocampus recorded as per nr2h formula by water displacement method, a maximum of 12 .50cc and a minimum of 10.80 on the right side were noted. The maximum of 12.30 cc of volume has been recorded on left hippocampus and minimum of 10.50 cc on the left side (Table 2; Figure 1).

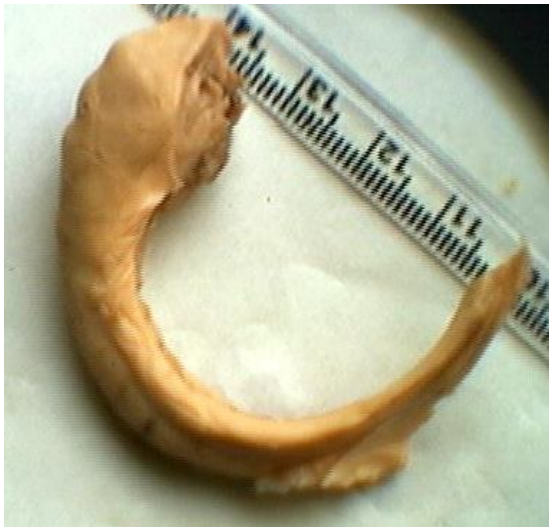

Figure 1: Showing Isolated Hippocampus For Adult Human Brain

No correlation existed between the maximum and minimum indices as far as weight and volume on right and left hippocampus were concerned most probably due to an asymmetrical measure and fiber composition.

DISCUSSION

In earlier studies on hippocampal volumes by MRI, in the normal population,the right hippocampus volume was between 1501.4 – 6010 mm3 while the left was 1880 – 5880 mm3 Niemann (2000). The reason for such a wide range could be the variation in the criteria of determining the boundaries in different MRI machines .As the present study was a direct investigation of isolated hippocampi the data obtained did not show so much variation in the values the volume of the right hippocampus was ranging from 10.80-12.50cc while that of left hippocampus showed a volume range of 10.50-12.30cc.
In the study of Kaan (2002). The effect of the size of brain on the volumes of hippocampus Was normalized using Gullap's [(1999) formula and Cavalieri's principle while performing volumetric measurements . After sending all the image data to a work-station hippocampus by a cursor in each section seen afterwards the area measurement was calculated automatically The sum of the areas, multiplied by the section thickness (3 mm) . mean of the normalized right–left difference for hippocampus volume was 150.47±121.83 mm3 (4.78-434.96). The present study showed a difference between the right and left hippocampus to be 0.20-0.30 cc. The study of Free SL(1995)showed the volume of male hippocampus to be slightly larger than that of a female hippocampus, while Cheon(1998) observed that the female hippocampal volume to be larger than the male Significant variation in the volumes of hippocampus with the changing age from 60 to 90 years was reported simultaneously stating that no such variation was observed in 40 to 60 age group Qiwen(1999). The present study is in agreement with studies of kaan (2002) which stated that there was no change in the volume of hippocampus with respect to the age or sex.

Conclusions

The present study would be a course reference during the metric analysis of hippocampus necessitated in conditions like Alzheimer's disease using non-invasive diagnostic tools such as MRI, provided the correction is applied to the shrinkage resulted from the formalin fixation. There is a Furtherance of study to obtain the data values of cytoarchitecture of hippocampus.

REFERENCES

Amaral DG and Insausti R (1990) Hippocampal formation In: The human nervous system. 2nd edn edited by Paxinos G (Academic Press, New York) 711-755.

Cendes F, Andermann F, Gloor P, Lopes-Cendes I, Andermann E, Melanson D, Jones-Gotman M, Robitaille Y, Evans A and Peters T (1993). Atrophy of mesial structures in patients with temporal lobe epilepsy: cause or consequence of repeated seizures? *Annals of Neurology* **34**(6) 795-801.

Cheon JE, Chang KH, Kim HD, Han MH, Hong SH, Seong SO, Kim IO, Lee SG, Hwang YS and Kim HJ (1998). MR of hippocampal sclerosis: comparison of qualitative and quantitative assessments. *American Journal of Neuroradiology* **19**(3) 465-468.

Free SL, Bergin PS, Fish DR, Cook MJ, Shorvon SD, Stevens JM (1995). Methods for normalization of hippocampal volumes measured with MR. *American Journal of Neuroradiology* **16**(4) 637-643.

Gullap S (1999). Temporal lob epilepsies in de hipokampusun volumetrik MR incelemesi. Specialization thesis. Department of Neurology, Gazi University Medical School, Ankara 25.

Gur RE, Turetsky BI, Cowell PE, Finkelman C, Maany V, Grossman RI, Arnold SE, Bilker WB, Gur RC (2000). Temporolimbic volume reductions in schizophrenia. *Archives of General Psychiatry* **57** (8)769-775.

Gray's Anatomy (1999). The anatomical basis of Medicine and Surgery 38th edn edited by Late Peter.L. William, (Churchill Livingstone, London) 1121-1129.

James W.Papez(1929) Comparative Neurology edited by Thomas Y. (Pub: Cruwell Company) 76-441.

Kaan Y ,Bahattin H, Mufit P and Hakan O (2002). Morphometry of some elements of limbic system in normal population: a quantitative MRI study *Neuroanatomy* **1** 15-21. Available: www.neuroanatomy .org

Lehericy S, Baulac M, Chiras J, Pierot L, Martin N, Pillon B, Deweer B,Dubois B, Marsault C (1994). Amygdalohippocampal MR volume measurements in the early stages of Alzheimer disease. *American Journal Of Neuroradiology* **15**(5)929-937.

Niemann K, Hammers A, Coenen VA, Thron A, Klosterkotter J (2000). Evidence of a smaller left hippocampus and left temporal horn in both patients with first episode schizophrenia and normal control subjects. *Journal of Psychiatry Research.* **99**(2) 93-110.

Qiwen M,Jingxia X, Zongyao W,Yagin W and Zhang S (1999). A Quantitative MR Study of the Hippocampus Formation, the Amygdala and Temporal Horn of the Lateral Ventricle in Healthy Subjects 40 to 90 Years of Age. *American Journal of Neuroradiology* **20**(2) 207-211.

Talmage LP (1955). The Neuroanatomical Basis for Clinical Neurology (Pub:Mc.Graw-Hill Book company , New York) 551-559.