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MORPHOMETRIC STUDY OF HUMAN FOETAL HIPPOCAMPUS

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ABSTRACT

Hippocampus is a component of limbic system associated with learning and memory. Anomalies resulting in the deficiencies of above functions will remit as a consequence of a change in the developmental morphology; hence to locate the changes normal developmental morphometric data is essential. In the present study Hippocampi which were dissected out from 45 unclaimed foetuses of gestational ages ranging from 15 wks to 39wks. The hippocampii which were isolated by lateral temporal approach were subjected to morphometric evaluation to obtain the following data. Maximum values of right hippocampus were recorded as follows weight 2.95 gm, length 4.59 cm, width 1.50cm, volume 5.98cc and surface area 6.89 cm² while left hippocampus values were observed as weight 2.90gms, length 4.50 cm, width 1.50 cm, volume 5.96 cc and surface area 6.75cm² (Table1). There was no influence of weight on volume.

Key Words: *Hippocampus, Limbic System, Morphometric Data and Temporal Approach*

INTRODUCTION

The Hippocampal formation itself consists of V shaped band of deeply stained cells the gyrus dentate and somewhat similar V shaped mass the cornu Ammonis so arranged that one limb of cornu Ammonis lies between divergent limbs of gyrus dentate. With the development of corpus callosum, gradual increase, in the size corresponding with the development of neopallial region of cerebral hemispheres occurs. Hippocampal formation rolls backwards, downwards and outwards into the temporal pole going into close relationship with the cortex of piriform lobe. The indusium griseum connects the pre commissural archicortex associated with precommissural septal region and hippocampus proper. This detailing of hippocampus was the work of Humprey (1967). The evolution of the non-invasive foetal neurological screening as magnetic resonance imaging (MRI) has fostered a need for the recording of morphometric data of hippocampus, to serve as a comparative reference base for the values obtained by such techniques. Abnormal hippocampal formations were evident in congenital brain anomalies as agenesis of the corpus callosum, lissencephaly, holoprosencephaly and temporal lobe epilepsy Atlas *et al.*, (1986) and Baker and Barkovich (1992). The morphometric data obtained from the dissection of the normal developing foetal hippocampii at various gestations would serve as a normal reference range of values at that corresponding gestation. The values not falling within this range hint some developmental neurological anomaly.

MATERIALS AND METHODS

The present study was done on 45 brains of unclaimed foetuses obtained from the Departments of Anatomy and Obstetrics of AMC and KGH during 1999 to 2002. The foetal gestational age ranges from 15 wks to 38 wks. The brains were fixed by injecting sufficient quantity of 10% formalin into the cranial cavity through the anterior fontanelle. After adequate fixation meninges were removed to examine and further the dissect in only normal brain. The temporal lobe is exposed, medial view of lateral ventricle on mid-sagittal section of cerebral hemisphere facilitates the identification and isolation of hippocampus by the lateral approach to temporal lobe. The following encephalometric 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 $\pi r^2 h$. Weight of the foetal brain without meninges was also included in the calculation of the above encephalometric indices.

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RESULTS

The weight of brain at 15 weeks of gestation was 10- gms and in full term it ranged from 300 gms to 410 gms while the minimum weight of hippocampus recorded as .230 gms and .235 gms of left and right sides respectively. In 15 weeks gestation age group the hippocampus constituted 2.3% of total brain weight, on left side and 2.35% on right side. The weight of a hippocampus gradually increased to a maximum weight of 2.95 gms on right side and 2.90 gm on left side which on right side constitutes to 0 .72% while on left side it was 0.71% of total brain weight (Table 2).

Table 1: Showing minimum and maximum values of all the parameters of hippocampii of both sides

S. No.	Morphometric Paramater	Range
1.	Gestational age Of foetuses	15-39 weeks
2.	Crown Rump Length	120- 370mm
3.	Weight of Hippocampus	Rt 0.230-2.95 Lt 0 .235-2.90
4.	Length of Hippocampus	Rt 2.7-4.59 Lt 2.6- 4.50 cm
5.	Width at Pes hippocampus	Rt 0.76 -1.50 Lt 0.75 -1.50 cm
6.	Surface Area of Hippocampus	Rt 2.05-6.89 Lt 1.95 -6.75 sq.cms
7.	Volume of Hippocampus	Rt 1.96-5.98 Lt 1.92-5.96 cc



Figure 1: Showing the hippocampii of 20 wks and 39wks gestation in-citu and a view showing the variations in sizes at various gestation ages

The total length of right hippocampus ranged from a minimum of 2.7 cm at 15 weeks of gestation to a maximum of 4.57 cm recorded at full term. The length of left hippocampus at 15 wks observed as 2.60 cm whereas at full term 4.5 cm (Fig. 1). The width of pes hippocampus on right side was 0 .76cm at 15 weeks and 1.5cm at full term while on left side was 0.75cm at 15 weeks of gestation and 1.50cm at full term. The surface area of right hippocampus at 15 weeks recorded to be 2.05 sq cms and 6.89 sq cm at full term. The left hippocampus at 15 weeks gestation was having a surface area of 1.95 sqcm whereas at full term 6.75 sqcm .The volume of hippocampus measured by water displacement method and calculated using nr2h formula yielded values of 1.96 cc at 15 weeks and 5.98 cc at full term on right side while on left side the volume of hippocampus was 1.92cc at 15 weeks and 5.96 at full term (Table 2).

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Table 2: Showing the master table of all the recorded values

Sl. No	Ages (wk)	C.R.length	Wt. Of bor	Human Foetuses Brain				Hippocampus							
				Wt. Brain		PerR	Percent.	Len. Rt.	Len. Lt.	Wid. Rt.	Wid. Lt.	S.A. Rt.	S.A. Lt.		
				Wt. Rt.	Wt. Lt.									Right %	Left %
1	15	120	90	10	0.235	0.230	2.35	2.30	2.70	2.60	0.76	0.75	2.05	1.95	
2	18	150	110	20	0.855	0.850	8.55	8.50	2.60	2.50	0.80	0.90	2.08	2.25	
3	20	185	430	90	1.550	1.660	15.50	16.60	2.70	2.60	1.00	1.00	2.70	2.60	
4	21	197	500	100	1.700	1.700	17.00	17.00	2.80	2.70	1.00	1.00	2.80	2.70	
5	22	210	650	100	1.654	1.650	16.54	16.50	3.00	3.00	1.00	1.00	3.00	3.00	
6	22	210	600	105	1.850	1.750	18.50	17.50	3.20	3.00	1.00	1.00	3.20	3.00	
7	23	219	760	110	1.780	1.700	17.80	17.00	3.10	2.90	1.00	1.00	3.10	2.90	
8	24	230	800	120	1.750	1.750	17.50	17.50	3.00	3.10	1.00	1.00	3.00	3.10	
9	25	240	700	130	1.750	2.000	17.50	20.00	4.20	4.19	1.30	1.20	5.46	5.03	
10	26	260	1550	155	2.000	2.100	20.00	21.00	4.30	4.30	1.20	1.20	5.16	5.16	
11	26	252	850	120	2.135	2.130	21.35	21.30	4.40	4.30	1.50	1.50	6.60	6.45	
12	27	265	1150	130	2.880	2.850	28.80	28.50	4.52	4.50	1.50	1.50	6.78	6.75	
13	27	263	950	160	2.880	2.850	28.80	28.50	4.53	4.50	1.50	1.50	6.80	6.75	
14	28	270	1000	145	2.200	2.180	22.00	21.80	4.56	4.50	1.50	1.50	6.84	6.75	
15	29	280	1058	158	2.805	2.800	28.05	28.00	4.52	4.50	1.50	1.50	6.78	6.75	
16	29	280	1000	200	2.050	2.045	20.50	20.45	4.53	4.50	1.50	1.50	6.80	6.75	
17	30	290	1100	160	2.086	2.080	20.86	20.80	4.54	4.50	1.50	1.50	6.81	6.75	
18	31	275	1100	175	2.084	2.080	20.84	20.80	4.55	4.50	1.50	1.50	6.83	6.75	
19	31	270	1900	190	2.180	2.165	21.80	21.65	4.56	4.50	1.50	1.50	6.84	6.75	
20	31	300	1050	200	2.170	2.160	21.70	21.60	4.55	4.50	1.50	1.50	6.83	6.75	
21	32	310	1100	200	2.250	2.200	22.50	22.00	4.53	4.50	1.50	1.50	6.80	6.75	
22	33	295	1100	190	2.145	2.045	21.45	20.45	4.52	4.50	1.50	1.50	6.78	6.75	
23	33	295	1350	230	2.160	2.145	21.60	21.45	4.53	4.50	1.50	1.50	6.80	6.75	
24	33	295	1300	240	2.170	2.160	21.70	21.60	4.52	4.50	1.50	1.50	6.78	6.75	
25	33	320	2300	300	2.300	2.300	23.00	23.00	4.58	4.50	1.50	1.50	6.87	6.75	
26	33	320	1200	170	2.290	2.280	22.90	22.80	4.57	4.50	1.50	1.50	6.86	6.75	
27	34	330	1300	175	2.000	2.120	20.00	21.20	4.56	4.50	1.50	1.50	6.84	6.75	
28	34	330	1400	190	2.128	2.121	21.28	21.21	4.55	4.50	1.50	1.50	6.83	6.75	
29	35	310	1850	240	2.600	2.500	26.00	25.00	4.55	4.50	1.50	1.50	6.83	6.75	
30	35	310	2300	300	2.570	2.500	25.70	25.00	4.56	4.50	1.50	1.50	6.84	6.75	
31	35	340	1450	280	2.230	2.125	22.30	21.25	4.55	4.50	1.50	1.50	6.83	6.75	
32	35	340	1100	195	2.400	2.125	24.00	21.25	4.50	4.30	1.50	1.50	6.75	6.45	
33	36	350	1700	275	2.670	2.600	26.70	26.00	4.53	4.50	1.50	1.50	6.80	6.75	
34	36	310	1800	280	2.670	2.620	26.70	26.20	4.55	4.50	1.50	1.50	6.83	6.75	
35	36	346	1500	300	2.340	2.230	23.40	22.30	4.58	4.50	1.50	1.50	6.87	6.75	
36	36	346	1450	350	2.235	2.120	22.35	21.20	4.57	4.50	1.50	1.50	6.86	6.75	
37	36	346	1350	195	2.400	2.200	24.00	22.00	4.56	4.50	1.50	1.50	6.84	6.75	
38	37	355	1420	268	2.135	2.040	21.35	20.40	4.53	4.50	1.50	1.50	6.80	6.75	
39	37	355	1900	275	2.380	2.250	23.80	22.50	4.51	4.50	1.50	1.50	6.77	6.75	
40	38	362	1600	260	2.150	2.030	21.50	20.30	4.52	4.50	1.50	1.50	6.78	6.75	
41	38	362	1090	160	2.125	2.100	21.25	21.00	4.20	4.15	1.50	1.50	6.30	6.23	
42	39	365	2850	300	2.860	2.800	28.60	28.00	4.55	4.50	1.50	1.50	6.83	6.75	
43	39	365	3100	410	2.950	2.900	29.50	29.00	4.59	4.50	1.50	1.50	6.89	6.75	
44	39	370	1800	380	2.300	2.190	23.00	21.90	4.52	4.50	1.50	1.50	6.78	6.75	
45	39	370	1800	350	2.700	2.500	27.00	25.00	4.52	4.50	1.50	1.50	6.78	6.75	

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At full term the foetal hippocampus occupied the entire length of inferior horn of lateral ventricle and showed all the parts of typical adult hippocampus. That is pes hippocampus with grooves, body, fimbria and fornix (Fig. 1).

DISCUSSION

Kier *et al.*, (1997) studied the events of development of hippocampus in fetuses of 13-24 wks of gestation using dissections, MR imaging and histology to mention various changing relations, appearance of hippocampal fissure by 13 to 14 wks, appearance of dentate gyrus and cornu ammonis as a consequence to the beginning of infolding was reported at 15 to 16 wks and in the graphical representation the author marked a length of around 3.8cm as the length of hippocampus at 24 wks. In the present the hippocampal fissure was observed at 15 wks and dentate gyrus at 18wks the length of the hippocampus at 24 wks was recorded as 3.10cm. present study showed a linear increase in the volume of hippocampus with the increase in the gestational age which is in agreement with the work of Francois *et al.*, (2011) and Gindes and Aliva (2011). Righini *et al.*, (2006) calibrated a relation between the Infolding angles of hippocampus with normal development of hippocampus similarly the morphometric data especially the volume of the hippocampus can be considered a tool of judging the milestones of normal hippocampal development. Francois *et al.*, (2011) after the cohort study of 3D MRI on 20 pregnant women concluded a linear increase of hippocampal volume with gestational age and the author recorded a variation in the values on immediate subsequent scan. Gindes and Aliva (2011) could successfully identify the fornix and hippocampus and measure the volume by Tran's vaginal transducer of ultrasound in 34 pregnant women the values obtained did not differ bilaterally but in the present study asymmetry was observed which is in agreement with Righini *et al.*, (2006).

Conclusion

The present study if corrected by applying shrinkage correction would initiate and influence the development of a very precise technique in the measurement of hippocampus using non invasive investigations such as ultrasound scan and MRI. Because the foetus is always mobile in utero. The furtherance of this study is to quantify the cytoarchitecture of hippocampus and to establish inter relationship between values of cytoarchitecture and morphometry.

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