

Morphometric Study of Hippocampus in Human Foetal Brains

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Abstract: The hippocampus in greek called as sea horse is a major component of human brains. There are two hippocampi, one on each side of brain. It is a part of Limbic system. The present work is the result of study of human fetal brains. The aim of the study is to describe the gradual development in fetuses along with its size, weight, volume, shape at different ages and its maximum height of development. The human material of this work consists of 50 fetuses obtained from gynecology department of KGH and VGH to the Department of Anatomy during 2009-2012. While the fetal gestational age ranged from 15 weeks to full term as judged by the Crown Rump length. At 15 weeks gestations the total brain weight constituted 10 gms and at full terms it is 410 gms. The hippocampus on both sides weighed 0.235 and 0.230 gms in right and left sides.

Key Words: hippocampus, limbic system, olfactory centre, subiculum.

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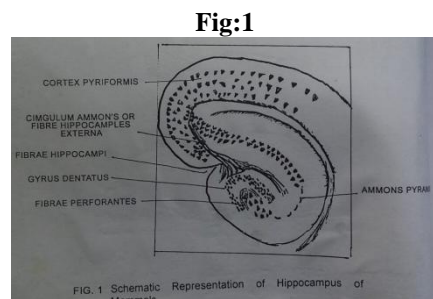
I. Introduction

Development of foetal Hippocampal formation (HF) has been difficult to fully describe because of rapid changes in its shape.¹ Hippocampus assumes the most amazing part of brain of all animals. It is located in the inferior horn of lateral ventricle. Behavior is a function of the entire nervous system regulated by brain. Certain of the most excellent contribution have been dealt with the hippocampal region of mammals, the functional connotations of the cortex of limbic brain is not easy to describe.

Hippocampus was supposed to be a constituent of olfactory center directly continuous 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. The abnormalities in HF have been associated with congenital cerebral malformations such as Lissencephaly, Holoprosencephaly and agenesis of corpus callosum.² as well as neuro psychiatric disorders like epilepsy.

Development of human foetal HF is of high interest as injury or deviation may cause neuro developmental burden to affected individuals.³

The Hippocampus is located under cerebral cortex in the allocortex and contains two main interlocking parts; the hippocampus proper and the dentate gyrus. Fig; 1.



The hippocampal primordium appears at the posterior part of lamina terminalis. The HF then undergoes rotation, Fig; 2, as well as other critical changes in second trimester.⁴ The dentate gyrus and cornu Ammonis slowly fold into temporal lobe as the hippocampal fissure slowly closes.⁵ By 18 – 20 weeks foetal HF looks like the adult Fig; 3. There is no gender difference or hemispheric changes understood till now.

Fig 2

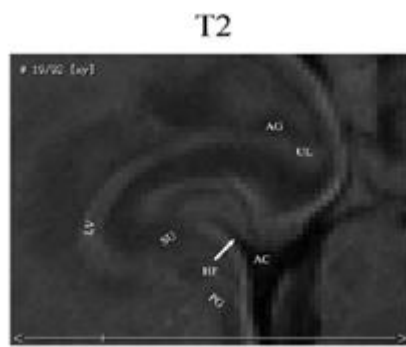


Fig:3



II. Materials And Methods

The present work is the result of study of human adult and fetal brains. The human material for this work 50 fetuses obtained from gynecology department of KGH and VGH from the Department of Anatomy from 2009 to 2012. While the fetal the gestational age ranged from 15 weeks to full term as judged by the Crown Rump length.

Similarly the dead fetuses obtained from department of Gyaenacology were perfused with 10% formalin and fetal brains were fixed by the injection of 10% formalin through the anterior fontenellae. Perfect hardening of human foetal brains took a little longer time in spite of taking all the precautions most probably due to the non-availability of sufficient of neuroglial tissue.

III. Results

Fetuses of gestational age from 15 weeks to full term have been subjected for morphmetric analysis of brains and hippocampus. The weight of the brain in 15 weeks is 10 gms and in full term it ranged from 300 gms to 410 gms. Table No: 1. The hippocampus is identified after dissecting the temporal lobe and the minimum weight of hippocampus is 0.230 gms and 0.235 gms in left and right sides. In 15 week gestation age groups the hippocampus constituted a minimum of 2.3% of total brain weight, on left side, and 2.35% on right side.

The weight of hippocampus gradually increased to a maximum weight of 2.95 gms on right side, 2.9 gms on left side has been recorded and this constitute 0.72% on right side, 0.71% on left side of total brain weight (Table No. I).

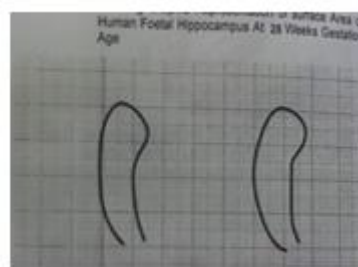
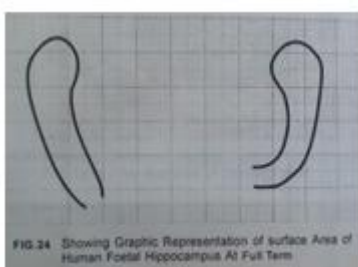
The total length of right hippocampus ranged from a minimum of 2.7 cm to a maximum of 4.57 cms recorded at full term .fig :4.



The length of hippocampus at 15 weeks gestation is 2.60 cm whereas at full term 4.5 cm (Fig . No. 5&6)



The width of pes hippocampus is 0.75 cm on right side at 15 cm at full term.
 The surface area of hippocampus at 15 weeks is 2.05 Sq . Cm on right side to 6.89 sq .cm at full term. (Fig . No.7) and (Table No. I)



The left hippocampus at 15 weeks gestation is having a surface area of 1.95 Sq. cm whereas at full term 6.75 Sq.Cm.
 The volume of hippocampus measured by water displacement method and calculated with $\pi r^2 h$ formula revealed on right side as 1.96 cc at 15 weeks, 5.98 cc at full term.

On left side the volume of hippocampus is 1.92 cc at 15 weeks gestation, on full term 5.96 cc (Table No. I)

At full term the fetal hippocampus occupied the entire length of inferior horn of lateral ventricle and showed all the parts of a typical adult hippocampus. That is pes hippocampus with grooves, body , fimbria and fornix (Fig.No. 8 &9)

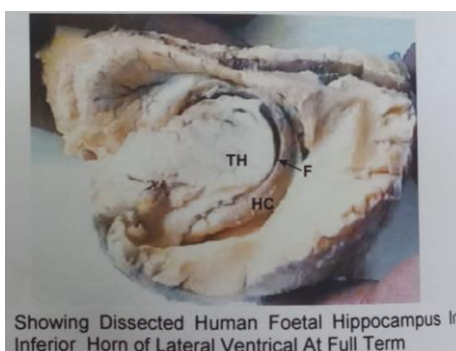


Table No:1

Human Foetuses Brain				Hippocampus											
Age (wks)	C.R. length	Wt of body	Wt Brain	Wt Rt	Wt Lt	PerR	Percent	Len. Rt	Len. Lt	Wid. Rt	Wid. Lt	S.A. Rt	S.A. Lt	Vol. Rt	Vol. Lt
						Right %	Left %	LR	LL	WR	WL	LR*WR	LL*WL		
15	120	90	10	0.235	0.230	2.35	2.30	2.70	2.60	0.78	0.75	2.05	1.95	1.96	1.92
18	150	110	20	0.855	0.850	8.55	8.50	2.60	2.50	0.80	0.90	2.08	2.25	2.50	2.45
20	185	430	90	1.550	1.660	15.50	16.60	2.70	2.60	1.00	1.00	2.70	2.60	1.96	1.95
21	197	500	100	1.700	1.700	17.00	17.00	2.80	2.70	1.00	1.00	2.80	2.70	3.73	3.73
22	210	650	100	1.654	1.650	16.54	16.50	3.00	3.00	1.00	1.00	3.00	3.00	3.78	3.70
22	210	600	105	1.850	1.750	18.50	17.50	3.20	3.00	1.00	1.00	3.20	3.00	3.78	3.72
23	219	760	110	1.780	1.700	17.80	17.00	3.10	2.90	1.00	1.00	3.10	2.90	3.78	3.74
24	230	800	120	1.750	1.750	17.50	17.50	3.00	3.10	1.00	1.00	3.00	3.10	3.88	3.70
25	240	700	130	1.750	2.000	17.50	20.00	4.20	4.19	1.30	1.20	5.46	5.03	4.91	4.89
26	260	1550	155	2.000	2.100	20.00	21.00	4.30	4.30	1.20	1.20	5.16	5.16	4.92	4.90
26	252	850	120	2.135	2.130	21.35	21.30	4.40	4.30	1.50	1.50	6.60	6.45	4.92	4.90
27	265	1150	130	2.880	2.850	28.80	28.50	4.52	4.50	1.50	1.50	6.78	6.75	4.93	4.91
27	263	950	160	2.880	2.850	28.80	28.50	4.53	4.50	1.50	1.50	6.80	6.75	4.94	4.92
28	270	1000	145	2.200	2.180	22.00	21.80	4.56	4.50	1.50	1.50	6.84	6.75	4.90	4.88
29	280	1058	158	2.805	2.800	28.05	28.00	4.52	4.50	1.50	1.50	6.78	6.75	4.97	4.95
29	280	1000	200	2.050	2.045	20.50	20.45	4.53	4.50	1.50	1.50	6.80	6.75	4.92	4.90
30	290	1100	160	2.086	2.080	20.86	20.80	4.54	4.50	1.50	1.50	6.81	6.75	4.90	4.88
31	275	1100	175	2.084	2.080	20.84	20.80	4.55	4.50	1.50	1.50	6.83	6.75	4.90	4.88
31	270	1900	190	2.180	2.165	21.80	21.65	4.56	4.50	1.50	1.50	6.84	6.75	4.80	4.78
31	300	1050	200	2.170	2.160	21.70	21.60	4.55	4.50	1.50	1.50	6.83	6.75	5.11	5.08
32	310	1100	200	2.250	2.200	22.50	22.00	4.53	4.50	1.50	1.50	6.80	6.75	5.15	5.13
33	295	1100	190	2.145	2.045	21.45	20.45	4.52	4.50	1.50	1.50	6.78	6.75	5.20	5.18
33	295	1350	230	2.160	2.145	21.60	21.45	4.53	4.50	1.50	1.50	6.80	6.75	5.30	5.28

IV. Observations And Conclusions

The volume of Hippocampus recorded by water displacement method is 12 cc to the maximum on right side and 12.03 cc on left side. No much volumetric trajectories seen. There is no correlation between maximum and minimum indices as per the volume and weight and volume on both sides of hippocampus.

At 15 weeks gestations the total brain weight constituted 10 gms and in at full terms it is 410 gms. The hippocampus on both sides weighed 0.235 and 0.230 gms in right and left side.

The gestational age of 15 weeks hippocampus constituted 2.3% of total brain weight on left side, 2.3% on right side. The weight of hippocampus is gradually increased and a maximum of 2.95gms weight of right side and 2.9gms weight on left side has been recorded. Fig No :2 The length of hippocampus at 15 weeks gestation 2.6cms where as at full term it is 4.5 cms. The surface area of hippocampus at 15 weeks gestational age is 2.05sq.cms on right side and 6.89 sq.cms at full term. The volume of hippocampus measured by water displacement method at 15 weeks gestation is 1.96 cc on right side and 1.2cc on left side, at full term the volume is 5.98 cc right side and 5.96cc on left side. volumes of both the left and right hippocampi increased almost linearly with increased gestational age. However, the rate of increase decreased after about 18 GW. This measurement almost equal to the one measured by MRI done by Xinting GE, Yongang Shi and Shuwei Liu as 5.83 .

The above indices almost tallied with the observations of D.W.Zaidel(1999). Hippocampal development is critical to many cognitive functions and several studies have been reported in the recent years. Thompson et al., 2009 found rightward asymmetry with no gender difference in full-term and preterm neonatal hippocampal volumes. Furthermore, Jacob et al., 2011 observed the fetal hippocampal development during the period of 21.3 GW to 31.9 GW using volume analysis and found a linear increase in total hippocampal volume with no hemispheric or gender difference. However, there are no prior volumetric or shape studies of fetal hippocampal development during the period in which the HF is known to rotate (10 GW to 24 GW).

Kier et al., 1997 succeeded in identifying changes of the HF in the fetal period (13 GW to 24 GW) and viewed the rotation process using MRI, dissections, and histologic sections of specimens. However, only 6, 5, and 2 specimens were qualified to acquire MR images, useful dissections, and histologic sections, respectively, which made the observation discontinuous and inadequate for volumetric analysis. Bajic et al., 2012 observed the development of the hippocampal sulcus using postmortem and in vivo MRI (17 GW to 36 GW). Asymmetry was observed, with the right HF developing faster than the left. However, the image quality and resolution were insufficient for volumetric analysis.

In comparison, postmortem specimens are advantageous for acquiring high quality images using high-field strength magnets, reduced slice thickness, smaller field of view and increased acquisition time, which are sufficient for quantitative analysis (Bajic et al., 2012; Zhan et al., 2013; Huang et al., 2006, 2009). our study was by dissections and it is more advantageous when done by square area and also water displacement methods. Which were tallying with the results of MRI findings. further studies on cytoarchitecture are going on and will give more information.

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