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A Post Mortem Study to Detect Any Variation in the Volume of the Human Pituitary Gland in Relation to Age

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Abstract

Context: *The pituitary gland is called "the master gland", as it controls the secretion of other important endocrine glands of the body. Various clinical problems may occur due to hypo-functional and hyper-functional state of the hormones of the pituitary gland. Therefore, the study is important to determine the normal variation of the volume of the gland with advancing age which will help to define its function at different stages of life.*

Materials & Methods: *A cross-sectional analytical type of study was carried out in the Department of Anatomy, Dhaka Medical College, on 60 human pituitary glands (40 male and 20 female)- collected from unclaimed dead bodies. The samples were divided into four groups. i.e. Group A (20-29 years), Group-B (30-39 years), Group-C (40-49 years) and Group-D (50-59 years). The three dimensions of pituitary gland (height, width and length), was recorded by using a digital slide calipers in mm and the volume of each pituitary gland was measured by applying the ellipsoid formula.*

Results: *The mean ± SD of volume of whole pituitary gland in different age group was 196.49 ± 43.82, 176.70 ± 53.58, 146.38 ± 39.10 and 107.13 ± 11.90 mm³ in group A, B, C and D respectively. The mean± SD of volume of the whole pituitary gland was186.11 ± 56.98, 160.47 ± 57.65,129.38 ± 28.06 and 107.13 ± 11.896 mm³ in group A, B, C and D in male respectively. In female the mean ± SD of volume was found 206.88 ± 24.29, 211.18 ± 15.77 and 197 ± 7.55 mm³ in group A, B, and C respectively.*

Conclusion: *The volume of the pituitary gland showed gradual decreasing values with advancing age. The mean ± SD of volume of male gland in this study was statistically lower than that of female glands.*

Key Word: *Volume, pituitary gland.*

Introduction

The pituitary gland together with the hypothalamus forms the most influential endocrine system in the body [1]. It is a reddish grey, ovoid body lies within the hypophyseal fossa of the sphenoid bone, covered superiorly by diaphragma sellae, which is pierced centrally by an aperture for the infundibulum[2]. It is attached to the hypothalamic region of the brain by a narrow stalk and has both neural and vascular connections with the brain[3]. Structurally the gland is divided into a larger anterior region (adenohypophysis) and a smaller posterior region (neurohypophysis). They differ in development, types, arrangement of cells, their vascular and neural supplies. The gland measures about 12 mm in transverse and 8 mm in antero-posterior diameter and weighs about 500 mg [2]. Physiologically adenohypophysis is important, as it produces hormones that regulate growth, metabolism, and reproduction[4]. If the activity of hypophysis decreases, the patient suffers greatly from reduced activity of the thyroid gland, the gonads and the adrenal cortex[5]. A post mortem

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study of about 50 adults (27 women aged from 22-84 years and 23 men aged from 36-75 years) revealed a highly significant difference in gland volume exists between the sexes. Mean female volume (range 399-827 mm^3) was greater than that of males (range 320 – 718 mm^3) [6]. Three dimensional MR volumetry on a clinical study group consisted of 199 Japanese children (from 0 to 19 years) showed the whole pituitary volume ranged from 157.9 to 523.7 mm^3, mean volume 386.0 mm^3 (Takano et al. 1999)[7]. An MRI study on volume of pituitary gland was conducted in Karachi, Pakistan. A total of 220 subjects aged ≤ 30 years were included in the study. Significant difference was observed in pituitary volume within different age groups in both genders. Mean pituitary volume in the first decade of life for females was 128 ± 73 mm^3, compared with 116 ± 62 mm^3 in the first decade of life for males. Volume increased to a peak gradually in the 2nd decade of life in females (316 ± 126 mm^3, n= 43) where in males it was 268 ± 118 mm^3. Volume peaked in the 3rd decade of life in males (309 ± 117 mm^3, n=41), whereas in females the mean volume was 298 ± 117 mm^3. When the data was further stratified into groups of 5 years, volume was found to be highest in the 16 to 20 year old age group of females (358 ± 102 mm^3, n = 21), and in the 21-25 year old age group in males (337 ± 103 mm^3, n = 20)[8]. Pathologically pituitary gland is important because of its endocrine effect, such as - increased or decreased secretion of hormones designated as hyperpituitarism and hypopituitarism respectively. Hyperpituitarism is caused mostly due to adenoma in the anterior lobe. Hypopituitarism may occur due to injury, radiation, inflammatory reaction, Rathke's cleft cyst, pituitary apoplexy, ischaemic necrosis of pituitary, empty sella syndrome and Sheehan syndrome. Posterior pituitary syndrome includes Diabetes insipidus, Syndrome of inappropriate ADH secretion (SIADH)[9]. Pituitary adenomas are indolent tumors, which accounts for 10-15% of all diagnosed intracranial neoplasms. Small adenomas may occur in up to 15% of pituitary glands examined at autopsy and over 20% in radiological examination[10]. The second most common type is somatotrophic adenoma - which is characterized by elevated level of Growth hormone- results in gigantism and acromegaly before and after closure of epiphysis respectively[9]. Hyperprolactinemia is found in less than half of the patients [11]. A prospective cross sectional study in the Northern part of Bangladesh was conducted on 113 consecutive female patients with infertility. The study reveals that, the prevalence of hyperprolactinemia accounts for about 43% and 21% of primary and secondary infertility respectively[12]. Most important disorder associated with deficiency of neurohypophysis is diabetes insipidus caused by diminished production of ADH (antidiuretic hormone), about 25% of patients have diabetes insipidus[11].

Materials & Methods

Materials

The present study was performed on 60 post mortem human pituitary glands of different age groups, of which 40 were males and 20 females. Among them, the lowest age was 22 years in both sexes and the highest age was 55 years (male) and 45 years (female).These entire samples were collected from the whole brains of the unclaimed dead bodies that were under examination in the Department of Forensic Medicine of Dhaka Medical College, Dhaka. After accomplishing all legal formalities the samples were collected within 24 – 36 hours of death. Soon after collection, each sample was gently washed with tap water on a dissection tray. Blood and blood clots were removed as far as possible. Then the samples were fixed in 10% formol saline solution.

Methods

Place and duration of study:

This study was carried out in the Department of Anatomy, Dhaka Medical College, Dhaka, from July 2009 to June 2010. During collection of the samples appropriate age, sex and the cause of death were

noted from morgue's record book and the samples were tagged bearing code numbers for subsequent identification immediately.

Grouping of the samples: The samples were divided into four groups by decade into age group A (20-29 years), group B (30- 39 years), group C (40-49 years) and group D (50-59 years)[13]. Detailed grouping and distribution of samples for morphological study were shown in Table –I.

Table- I
Grouping of the samples

Group	Age limit in years	Number of samples	
		Male	Female
A	20-29	09	09
B	30-39	17	08
C	40-49	09	03
D	50-59	05	00

Measurement of length, width and height of the pituitary gland:

These parameters were measured by using a digital slide calipers in mm (Fig.-1). The length of the gland was measured from antero-posterior distance of the gland [14]. The width of the gland was measured from the distance between the highest points of the lateral edges. Height of the gland was measured from the centre of the concavity that usually forms the superior surface of the gland (where no concavity, the greatest supero - inferior dimension)[6]. At each parameter three readings were taken and the average result was noted down.

Measurement of volume of each pituitary gland:

Volume of each pituitary gland was calculated by applying the ellipsoid formula, which requires measurement of the three dimensions of pituitary gland (height, width and length). The volume was measured in mm³.The ellipsoid volume formula is as follows:

Volume= 0.5 (Length X Height X Width) [6]

Ethical Clearance:

This study was approved by Ethical Review Committee of Dhaka Medical College, Dhaka.

Results

Results are shown in the Table–II & III.

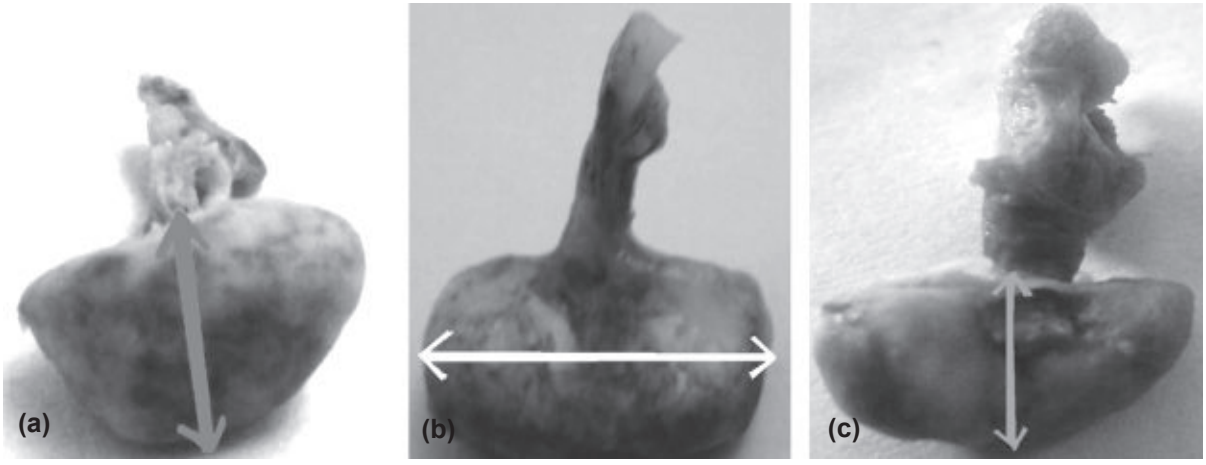

Fig-1: *Showing the antero-posterior distance (A=length) from the inferior view and the transverse distance (B=width) and the supero-inferior distance (C=height) of the pituitary gland from the anterior view.*

The mean± SD of volume of the whole pituitary gland was186.11 ± 56.98, 160.47 ± 57.65,129.38 ± 28.06 and 107.13 ± 11.896 mm³ in group A, B, C and D in male respectively. In female the mean ± SD of volume was found 206.88 ± 24.29, 211.18 ± 15.77 and 197 ± 7.55 mm³ in group A, B and C respectively. Differences were noted in the mean ± SD of volume between male and female in group B and C which was statistically significant (P < 0.01) (Table-II).

Table –II

Results of the Length, Width and Height of the pituitary gland in Male & Female & of both sexes

Group (Age)	Number (n)	Length (mm) Mean ± SD	Width (mm) Mean ± SD	Height (mm) Mean ± SD
A (20-29 years)	M = 09	M=6.29 ± 0.54	M=11.35± 0.82	M= 5.12 ± 0.93
		(5.35 – 7.11)	(10.55-12.69)	(3.77 – 6.70)
	F = 09	F=6.41 ± 0.44	F= 11.38 ± 1.14	F=5.70 ± 0.52
	Total = 18	(5.06 – 7.30)	(9.97– 12.79)	(4.49 – 6.33)
		Both sexes	Both sexes	Both sexes
		6.35 ± 0.48	11.37 ± 0.96	6.35 ± 0.48
		(5.35- 7.30)	(9.97 -12.79)	(3.77-6.83)
B (30-39 years)	M = 17	M=5.63 ± 1.09	M=10.28± 0.83	M=5.42 ± 1.02
		(4.19 – 7.7)	(8.32 – 12.53)	(3.68 – 6.93)
	F = 08	F= 6.59 ± 0.79	F=10.76 ± 0.40	F= 6.03 ± 0.46
		(5.32 – 7.62)	(10.1– 11.23)	(5.50 – 6.80)
	Total = 25	Both sexes	Both sexes	Both sexes
		5.93 ± 1.08	10.43 ± 0.74	5.69 ± 0.86
		(4.19-7.7)	(8.32 -12.53)	(3.68 - 7.03)
C (40-49 years)	M = 09	M=5.32 ± 0.56	M=9.94 ± 1.50	M=4.86 ± 0.35
		(4.38 – 6.28)	(8.31–12.87)	(4.16– 5.12)
	F = 03	F=5.46 ± 0.14	F=10.66 ± 0.19	F=6.78 ± 0.03
		(5.32 – 5.6)	(10.35– 10.88)	(6.75– 6.80)
	Total = 12	Both sexes	Both sexes	Both sexes
		5.35 ± 0.48	10.12 ± 1.32	5.34 ± 0.92
		(4.38 -6.28)	(8.31-12.87)	(4.16 – 6.80)
D (50-59 years)	M = 05 F = 00	5.11 ± 0.27	9.07 ± 0.38	4.62 ± 0.38
	Total = 05	(4.75- 5.5)	(8.50-9.50)	(4.14 -5.38)

The mean ± SD of volume of whole pituitary gland in different age group was noted as 196.49 ± 43.82, 176.70 ± 53.58, 146.38 ± 39.10 and 107.13 ± 11.90 mm^3 in group A, B, C and D respectively. The highest value was found in group A and the lowest one was found in group D. Significant differences were found in mean± SD of total volume of pituitary gland in between group A and C (P< 0.01), group A and D (P < 0.01) and group B and D (P < 0.01) (Table-III).

Table – III

Results of Volume of the pituitary gland

Group (Age)	Number (n)	Volume (mm^3) of Male & Female pituitary gland Mean ± SD	Volume (mm^3) of both sexes Mean ± SD
A (20-29 years)	M = 09	Male = 186.11± 56.98 (126.76 – 302.70)	196.49 ± 43.82 (126.76- 302.70)
	F = 09	Female = 206.88 ± 24.29 (163.39 – 234.06)	
	Total = 18		
B (30-39 years)	M = 17	Male = 160.47 ± 57.65 (66.93 – 301.07)	176.70 ± 53.58 (66.93 -301.07)
	F = 08	Female = 211.18 ± 15.77 (190.82 – 237.91)	
	Total = 25		
C (40-49 years)	M = 09	Male = 129.38 ± 28.06 (75.70 – 158.06)	146.38 ± 39.10 (75.70-205.63)
	F = 03	Female = 197 ± 7.55 (180.83 – 205.63)	
	Total = 12		
D (50-59 years)	M = 05	Male = 107.13 ± 11.896 (95.09 – 120.57)	107.13 ± 11.90 (95.09 – 120.57)
	F = 00	Female = 00	
	Total = 05		

Figure in parenthesis indicates range. During statistical analysis, comparison between the sex was done by unpaired student's 't' test & in between different age group that was done by One way ANOVA test.
P >0.05 $^{ns;}$ Volume between male & female gland in group A.
P < 0.01 **; Volume between male & female gland in group B.
P < 0.001***; Volume between male & female gland in group C.
P < 0.01 **; Volume between group A & C, A & D, B & D.
P >0.01 $^{ns;}$ Volume between group A & B, B & C and C & D.
Note: n = Number of samples, SD = Standard deviation,
ns = not significant, **= significant.

Discussion

The mean ± SD of volume of the whole pituitary was 196.49 ± 43.82, 176.70± 53.58, 146.38±39.10 and 107.13± 11.90 mm³ in group A, B, C and D respectively which was much lower than that of other studies. McLachlan et al in 1968 found the mean volume of the gland to be 320-718 mm³ in male and 399-827 mm³ in female by conducting a radiological study on 50 adult post mortem sample (23 from male and 27 from female)[6].The reason of this difference may be due to racial variation of the study population .The whole pituitary volume ranged from 157.9 to 523.7 mm³ (mean volume 386.0 mm³) according to Takano et al. 1999 in Japan, where only the lower limit remained close to the volume of group B in the present study[7]. The present study also revealed that the volume of the whole pituitary was significantly ($P < 0.01$) greater in female subjects than that in male subjects observed in group B and group C which was similar to that of Ikram et al. 2007, who conducted an MRI study on volume of pituitary gland over 220 subjects aged < 30 years (129 male and 91 female). In male the volume was observed to be peaked in the 2nd decade of life (186.11 ± 56.98 mm³) but statistically not significant ($P >0.05$) and in female in the 3rd decade of life (211.18 ± 15.77mm³) which was statistically significant ($P< 0.01$) for the present study and was dissimilar to that of the Ikram et al[8]. But the present study also revealed a gradual, statistically significant ($P< 0.01$) decrease in volume with age which was apparently dissimilar to that of Ikram et al[8].

Conclusion

The observation and results of the present study are expected to standardize the volume of the pituitary gland in Bangladeshi people. Volume of the pituitary gland showed gradual decreasing values with advancing age & females have larger volume than that of males, which was statistically significant. Further studies to find out the cause of decrease in parameter & gender differences are recommended.

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