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Study of Morphological Features of Thymus Gland In Human Foetuses At Different Age Group

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Abstract
Introduction*: The thymus is a lymphoid tissue located in superior and anterior mediastinum,and is responsible for the development, differentiation and clonal expansion of T lymphocytes .*
Aims of study- A cross sectional study conducted to study of morphological features of thymuses of human foetuses.
Material and methods*:In present study 16 dead foetuses are collected from the dept. of Obs and Gynae. UPUMS Saifai after taking the permission of ethical committee. The collected foetus now divided into three groups, first group ranging from 10 wks to 20 wks,second group ranging from 21wk to 30 wk and third group ranging from 31 wk -40wk.these foetuses dissected and their thymus gland so obtained was studied for t heir morphological features.*
Result: This study revealed that there are significant morphological changes in different age group, which are progressive from first group to third group. The significant growth is seen in third group i.e. in 31wk -40 wk.
Keywords: *Foetuses, Lymphoid Tissue, Clonal Expansion, Mediastinum*

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I. Introduction

The name **Thymus** comes from the Latin derivation of Greek thymos, meaning "watery excrescence", due to its resemblance to the flower of thyme plant. It is reported that Galen[1], (130-200AD), first described the morphology of this gland and it has attracted sporadic interest ever since particularly in the 1900, when hyperplasia was noted to occur in conjunction with myasthenia gravis. Thymectomies performed to ameliorate this and other conditions were reported (Veau[2], 1910, Schumacher & Roth [3]1912).

Thymus was recognized by Greeks; the function of this gland had remained enigmatic until recently when science of immunology started to elucidate the origin and function of peripheral lymphocytes in diseases. It is now understood that the function of this primary lymphoid organ was to generate most, if not all of the circulating T- cell repertoire and to control the production of self major histo-compatibility (MHC) class II antigen restricted lymphocyte to ensure that only lymphocyte capable of correctly distinguishing self from non-self antigen were let loose in the body. This process was referred to as **education** and error in education were eliminated (negative selection) whilst the correct education process resulted in the cloning of this selected thymocyte (positive selection). Thymocytes were subjected both to positive and negative selection in thymus, but these processes might well continue among post thymic T-cells in the periphery. Failure to educate thymocyte correctly or to control the release of miseducated T- cell resulted in disease, especially auto-immune condition. The thymus is one of the two primary lymphoid organs (the other being the bone marrow). It is responsible for the provision of thymus-processed lymphocytes (T lymphocytes) to the whole body. The thymus provides a unique microenvironment in which the T-cell precursors (thymocytes) undergo development, differentiation and clonal expansion. The organ is also part of the neuroendocrine axis of the body, and it both influences and is influenced by the products of this axis.

The greater part of the thymus lies in the superior and anterior inferior mediastinum, the lower border of the thymus reaching the level of the 4th costal cartilages. Superiorly, extensions into the neck are common reflecting the (bilateral) embryonic origins of the thymus from the third pharyngeal pouch it sometimes reaches the inferior poles of the thyroid gland or even higher. Its shape is largely moulded by the adjacent structures. Anterior are the sternum, adjacent parts of the upper four costal cartilages and the sternohyoid and sternothyroid muscles. Posterior are the pericardium and the aortic arch with its branches, the left brachiocephalic vein and the front and sides of the trachea. The appearance of the thymus varies considerably with age. It is largest in the early part of life up to the age of about 15, although it persists actively into old age. It is a soft, bi-lobed organ, its two parts lying close together side by side, joined in the midline by connective tissue which merges with the capsule of each lobe. In children it is more pyramidal in shape and firmer than in later life, when its lymphoid

content is reduced. In the fresh state it is deep red due to its rich vascular supply; with age it becomes thinner and greyer before yellowing as adipose tissue infiltrates the organ, a process which is independent of obesity. Its weight also varies with age at birth it is 10–15 g and rapidly increases to about 20 g, then remains at that level thereafter, although the amount of lymphoid tissue gradually decreases. The older thymus can be distinguished from the surrounding mediastinal fat only by the presence of its capsule, although even within greatly atrophied glands there are usually greyer areas around blood vessels, formed by persistent lymphoid tissue.

Ectopic thymic tissue is found in 25% of the population **(Goldstein & MacKay [4]1969);** small accessory nodules may occur in the neck representing portions which have become detached during their early descent, or the thymus may be found even more superiorly as thin strands along this path, reaching the thyroid cartilage or above. Connective tissue marking the line of descent during early development may, in some instances, run between the thymus and the parathyroids.

Measurements of thymus size appeared to be useful in young human subjects and revealed for instance, that breast fed infant had thymuses on average twice the size of those in formula fed infants (Hasselbalch et al[5], 1995) and that thymic size at 3 month of age was a powerful predictor of infant mortality in developing country setting (P.Aaby et al[6], 1999)

II. Aims And Objective

The proposed work consists of the aim to study the morphological features of thymus gland at different age group.

Following point to be studied-

1. Cervical extension of thymus gland.
2. Length of the right and left lobeof thymus gland.
3. Thickness of thymus gland
4. Maximum width of thymus gland.
5. Weight of thymus gland.

III. Material And Methods

HUMAN FOETUSES

- Total number of foetuses considered: 16
- Collection: Foetuses were obtained from the department of Obsetrics&Gynaecology, RIMS Saifai.
- Selection: Foetuses of all groups without obvious any gross congenital anomalies were selected for study.
- Preservation of foetuses: Foetuses were well preserved in jars containing 10% formalin solution, after incision had been made to open their cranial cavity, thorax and abdomen to properly fix different organs of the body.
- Assessment of gestational age: Streeter's data (Streeter7, 1920) was used to determine the gestational ages of foetuses .
- Streeter's Data **(FIGURE 1)**

STREETER'S DATA: FOR ESTIMATION OF AGE FROM FOOT LENGTH

Gestational age (weeks)	Foot length (in mm.)
11	7
12	9
13	11
14	14
15	17
16	20
17	23
18	27
19	31
20	33
21	35
22	40
23	42
24	45
25	48
26	50
27	53
28	55
29	57
30	59
31	61
32	63
33	65

34	68
35	71
36	74
37	77
38	79
39	81
40	83

GROUPING OF FOETUSES

- Group I : upto 20 wks
- Group II : 21-30 wks
- Group III : 31-40 wks

INSTRUMENTS

- Vernier callipers.
- Dissecting set comprising of scissors, scalpel with blade, forceps -toothed and plane, foetus holding stands artery forceps and dissecting needles.
- Instruments of micro-dissection.
- Dissecting tray.
- Geometry set.
- Weighing machine.
- Dissecting microscope.
- Glass slides
- Graph papers
- Filter papers
- Cotton
- Methylene blue solution.
- Small jars for tissue preservation

MEASUREMENTS PRIOR TO DISSECTION

- Head circumference (in cm): Maximum diameter of the head was taken into consideration at the level of external occipital protuberance posteriorly and supra-orbital ridge anteriorly.
- Foot length (in mm): measured from posterior most point of sole to tip of great toe or second toe which one is larger.
- Crown rump length (in cm): Measurement from the skull vertex to the midpoint between the apices of the buttocks of foetus.
- Weight of foetuses: foetuses were weighed by using weighing machine.

DISSECTION PROCEDURE (Figure 2)

- A midline incision from symphysismenti to Xiphisternum.
- Retraction of skin and superficial fascia.
- Elevation of sternum through right paramedian incision and cutting the all seven costo-chondral junctions and attachment of right clavicle.
- Separation of thymus from other tissues.
- Thymus was removed en mass by separating it from other tissues.

MEASUREMENTS (Figure 3)

Following parameters were used

- Maximum length of each half (includes horn & lobe) –Right and left.
- Maximum length of each lobe- Right and left.
- Maximum width of each lobe:-Right &left
- Maximum attained width of tissue.
- Maximum thickness of each lobe
- Weight of thymus:- It was taken by using single pan digital weighing instrument.

STATISTICAL ANALYSIS

Readings were analyzed by using student's t test. P value of <0.05 was considered significant, and $P<0.001$ was highly significant by using SPSS software.

IV. Results

Table showing division of sample into three groups I, II, III according to gestational age.

Gestational age groups	Number	Percent
I (up to 20wks))	5	31.25
II(21-30wks))	6	37.50
III (31-40 wks)	5	31.25
Total	16	100.00

TABLE-2: LENGTH OF RT.LOBE (CMS)

Group	No. of cases	Mean ±SD	Percent change
I (up to 20 weeks)	5	0.98±0.47	
II (21-30wks)	6	1.634±0.33	66.33
III (31-40wks)	5	3.94±1.05	302.04

TABLE-3: LENGTH OF LT.LOBE (CMS)

Group	No. of cases	Mean ±SD	Percent change
I (up to 20 weeks)	5	0.90±0.479	
II (21-30wks)	6	1.65±0.56	83.33
III (31-40wks)	5	3.86±0.65	328.89

TABLE-4: WIDTH OF RT. LOBE (CMS)

Group	No. of cases	Mean ±SD	Percent change
I (up to 20 weeks)	5	0.40±0.14	
II (21-30wks)	6	0.87±0.29	117.50
III (31-40wks)	5	3.34±0.70	735.00

TABLE-5: WIDTH OF LT.LOBE (CMS)

Group	No. of cases	Mean ±SD	Percent change
I (up to 20 weeks)	5	0.44±0.23	
II (21-30wks)	6	0.72±0.40	63.64
III (31-40wks)	5	3.46±0.58	686.36

TABLE-6: THICKNESS OF RT.LOBE

Group	No. of cases	Mean ±SD	Percent change
I (up to 20 weeks)	5	4.14±0.21	
II (21-30wks)	6	6.68±0.43	61.35
III (31-40wks)	5	10.16±1.15	145.41

TABLE-7: THICKNESS OF LT.LOBE

Group	No. of cases	Mean ±SD	Percent change
I (up to 20 weeks)	5	2.86±0.35	
II (21-30wks)	6	5.45±0.54	90.56
III (31-40wks)	5	8.92±1.07	211.89

TABLE-8: WT. OF THYMUS

Group	No. of cases	Mean ±SD	Percent change
I (up to 20 weeks)	5	0.594±0.336	
II (21-30wks)	6	1.990±0.880	235.02
III (31-40wks)	5	8.569±3.011	1342.59

V. Discussion

Thymus is a ductless gland so it belongs to endocrine system as well as produce hormones that enhances the strength of immune system and is a central site of T cell maturation.

Foetal development is influenced by multiple factors which affects the rate of development with time. Scammon and catkins[8] (1929) and Waszak M[9] (2003) observed that after 5 months, rate of devemopment begins to decrease. They also observed that female fetuses appear developmentally older than male foetuses by analyzing most of morphological features except thymus and adrenal gland which have continuous growth.

In our study, the position of the thymus gland was upto the right lobe of thyroid gland in all groups except one in group 1 in which thymus gland extend upto suprasternal notch, and one specimen in group 3 where thymus gland was found upto the diaphragm. Dr. Krishnamurthy JV and V. SubhadraDevi[10] studied the cervical extension of thymus gland in preterm and post term fetuses, and found the cervical extension, ranged from suprasternal notch to level above the thyroid cartilage. They found in one specimen where right lobe is extended upto diaphragm as we found in our study.

The mean length of rt. lobe of thymus in our observation in cm was (0.98± 0.47) in group I, (1.63 ± 0.33) in group II and (3.94± 1.05) in group III.Yekeler et al[11] (2004) measures the maximum cranio caudal length. 31.2±4.4 cm in foetus of 31-40 weeks i.e. III[rd] group in this study. which is 39.4± 10.5 cm.This shows progressive growth of foetal thymus from group I to groups II which becomes more rapid from group II to group III. The maximum Transverse dimension in cm. of right lobe of Thymus in Group I, II & III are (0.40±0.14), (0.87±0.29) & (3.34±0.70) which shows two times in group II in comparison to group I & 4 times in group III in comparison to group II ($P < 0.001$) The transverse diameter of left lobe in cm. in group I, group II & group III was (0.44± 0.23), (0.72 ±0.40) to (3.46± 0.58) respectively, which is showing progressive growth. Yekler et al (2004) measured the maximum transverse dimensions of thymus in foetus (31-40 weeks) and found mean value to be 29.3± 3.3mm.The weight of thymus in group I is (0.594±0.336) in group II is (1.99±0.88) & group III is (8.56±3.01) which shows two times growth in weight of thymus in groups I to group II whereas 8 times growth from group II to group III. This shows highly significant group in group III foetuses.Waszaket. Al (2003) studied the weight of thymus in 20-42 weeks of 3389 foetus. They found the weight of thymus about 9.38 gm. in male fetuses and 8.16 gm female featus.

VI. Conclusion

- All parameters showed significant higher growth rate in group III fetuses.
- Right and left halves of thymus followed similar growth pattern in all parameters.
  So, our morphometric studies were suggested that foetal thymus developed very rapidly after the 30 wks age of intra-uterine life i.e. in group III.

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FIGURE 1: Measurement of foot length for estimation of gestational age

Figure 2: Dissection of fetal thymus

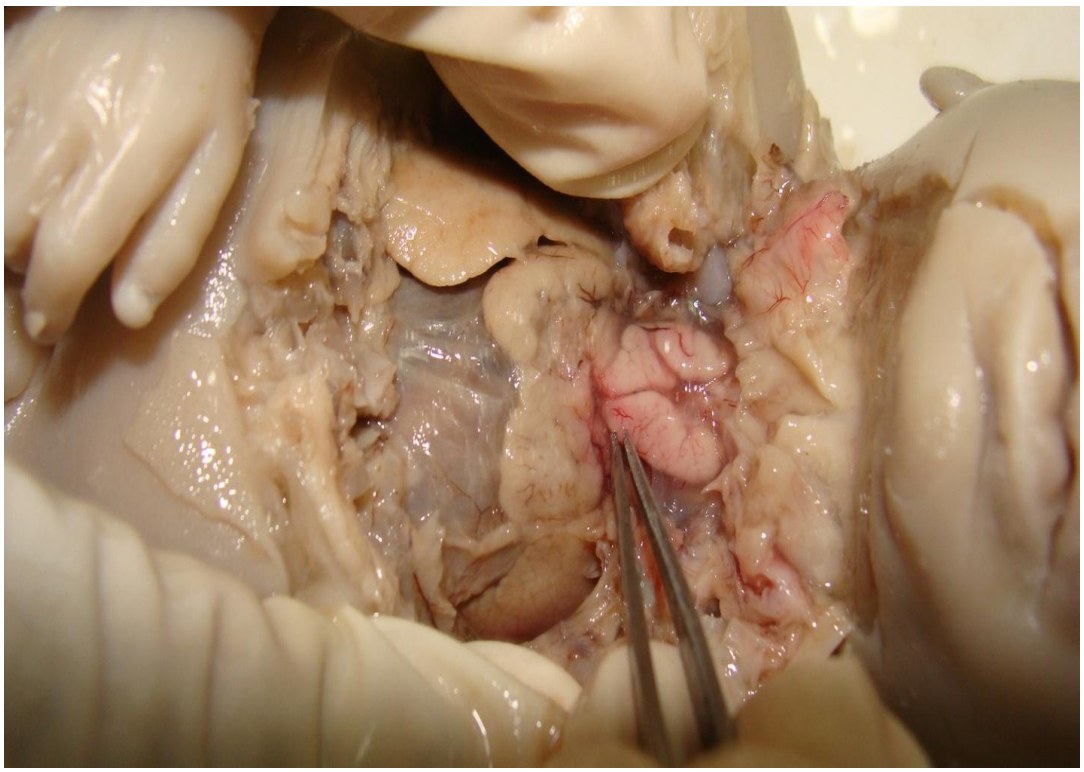
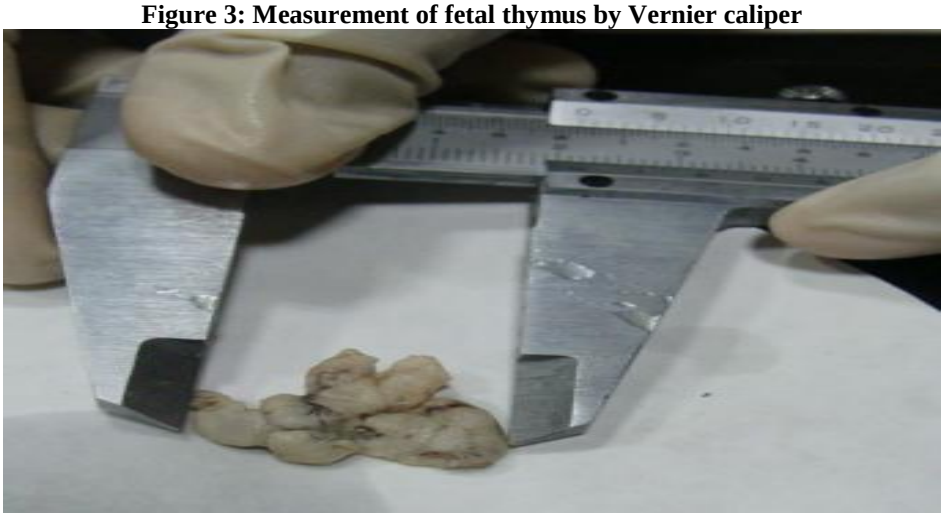


Figure 3: Measurement of fetal thymus by Vernier caliper



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