

MORPHOLOGICAL FEATURES AND MORPHOMETRIC PARAMETERS OF HUMAN FETAL THYMUS GLANDS

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ABSTRACT

Introduction: Thymus is one of the central lymphoid organs. It plays an important role in the differentiation, selection and maturation of T-lymphocytes. In the recent years morphology and morphometry of the thymus gland in the newborn is gaining significance as it demonstrates great variability between individual infants and in the same infant at different times.

Materials and methods: In the present study 45 thymus specimens from aborted human fetuses of 16 to 40 weeks gestational age and both sexes were studied by autopsy for morphological and morphometric features. The morphometric parameters were measured using pachymeter.

Results: The thymus gland was located in the superior mediastinum. 60% (27/45) specimens showed cervical extensions. Brachiocephalic vein anterior to thymus was observed in 3 cases which is an important anomaly to be observed in thymectomy procedure. Thymuses were greyish pink to greyish brown in colour. Variations were also observed in the number of lobes of glands in which one is single lobed, most of the glands are bilobed and few are trilobed. There is progressive increase in all morphometric dimensions of the thymus in relation to gestational age. Most of the specimens were less than 4cm in length. Half of the specimens were below 2cm in width and other half were 2.0 to 5.0 cm in width. For 90% of the specimens thickness of the organ was less than 0.5cm. The thymus gland was 0.2% of fetal body weight.

Conclusion: The morphological observations of thymus gland shows great variations which has to be considered in thymectomy. In addition to anthropometric parameters of fetus, morphometric parameters of thymus glands present significant relation to the gestational age of fetuses. It is possible to determine the thymic morphometric parameters in relation to gestational age.

KEYWORDS: Thymus Gland; Thymectomy; Foetus; Morphometric Parameters.

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Access this Article online

Quick Response code



Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 06 Dec 2013

Peer Review: 06 Dec 2013 Published (O):19 March 2014

Accepted: 19 Feb 2014 Published (P):30 March 2014

INTRODUCTION

Thymus is one of the central lymphoid organs which play an important role in the differentiation, selection and maturation of T-lymphocytes. Thymus demonstrates a variety of clinical (thymic hyperplasia) and congenital diseases. The differentiation of the thymus from

other mediastinal structures, such as lymph nodes or the superior sinus of the pericardium, may be difficult. Therefore, it is important to be familiar with morphology of thymus gland for determining the effect of clinical and physiological conditions [1].

Thymus gland is soft and spongy in texture and situated in the superior mediastinum and anterior part of inferior mediastinum. It develops from 3rd pharyngeal pouch. Ectopic thymus, accessory nodules, cervical extensions and thymus behind left brachiocephalic vein are more common variations [2, 3]. It extends from the neck superiorly to 4th or 5th costal cartilages inferiorly [2, 4]. The shape of the thymus is variable. According to different authors [2, 3, 5] it is H, Triangular or Pyramidal in shape, which is molded by adjacent structures. The longitudinal scans of ultrasound and radiographic studies proposed triangular, tear drop, oval and sickle shapes [6]. The color of thymus changes with the age. It is pink grey to brown in prenatal, becomes gray during infancy and yellow in adulthood [2 - 4].

The size of the thymus in the newborn is gaining significance in recent years which demonstrates great variability between individual infants and in the same infant at different times. The morphometric measurements of thymus are useful in calculating its size. Diminished thymus size in seriously malnourished infants concludes that there may be a relationship between the size of thymus and the status of cellular immune deficiency of the infant [7, 8]. In addition to anthropometric parameters, thymus size can be another indicator of malnutrition, chronic disease or other negative factors [9].

Several morphometric studies on fetal internal organs in both animals and humans were available in the literature. Studies relating to morphological features and morphometric parameters of thymus glands are limited [5]. Based on wide morphological variations mentioned by different authors and limited literature on morphological and morphometric parameters on thymus gland, the present study on human foetal thymuses were undertaken to determine their morphological features and gestational age related morphometric parameters.

MATERIALS AND METHODS

This work was conducted at the department of Anatomy, S.V. Medical College, Tirupathi with the co-operation of Department of Anatomy, Department of Pathology, SVIMS and Government

maternity hospital, Tirupathi, Andhra Pradesh, India.

A total of 45 dead fetuses of 16 weeks to 40 weeks gestational age and both sexes obtained from the Government Maternity Hospital, Tirupati with relevant obstetric records and preserved in Department of Anatomy S.V. Medical College, Tirupati were utilized for this study. This has got the approval of institutional ethical committee. The fetuses were categorized in to three gestational age groups of less than 24 week (Group I), 25- 35 weeks (Group II) and more than 36 weeks (Group III).

By giving midline incision over the sternum with superior extension into the neck and inferolateral extension along costal margins followed by reflection of skin and soft tissues, resection of ribs and clavicle and separation of thoracic organs the thymus gland with its extensions if any in to the neck is exposed. The gland was observed in situ for its relations. Later the thymus gland is scooped out from the mediastinum.

Morphometric parameters like length, width, thickness, weight and percentage of thymic weight to fetal weight were measured. Length, Width and Thickness of the Thymus were measured with pachymeter and were recorded in cm for convenience of this study. The organ was spread on plain table. Length of the two lobes was measured. The Width is measured at the widest part of the organ along the horizontal plane. The Thickness is measured by holding one lobe with forceps and measuring another lobe in the middle along the anteroposterior plane (Fig.1, 2, 3). The weight in grams was performed with an electronic balance. The organs were washed in running water, dried and then weighed. The percentage of thymus weight to fetal weight is calculated with relevant statistics.

RESULTS

Out of 45 cases studied, 20 (44.4%) belongs to gestational age between 15 to 24 weeks (Group I), 22 (48.9%) were between 25 to 35 weeks (Group II) and 3 (6.7%) belong to > 35 weeks (Group III). In relation to fetal weight, the largest number of cases i.e., 32 (71%) were < 1000gms.

Fig. 1: Measuring the Length Of Thymus Gland



Fig. 2: Measuring The Width Of Thymus Gland.



Fig. 3: Measuring the Thickness Of Thymus Gland

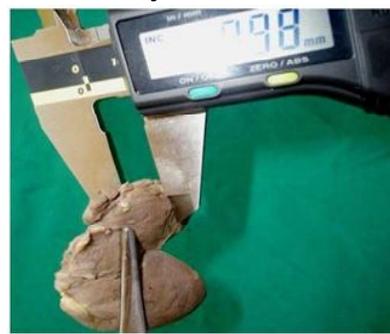


Fig. 4: Thymus Gland (T) Situated In The Anterior Mediastinum Upon The Heart (H). Brachiocephalic Vein Is Posterior To The Thymus (Blue Arrow). Lungs (L) Lateral To The Gland.



Fig. 5: Thymus Gland (T) Situated In Anterior Mediastinum Anterior To Brachiocephalic Vein.

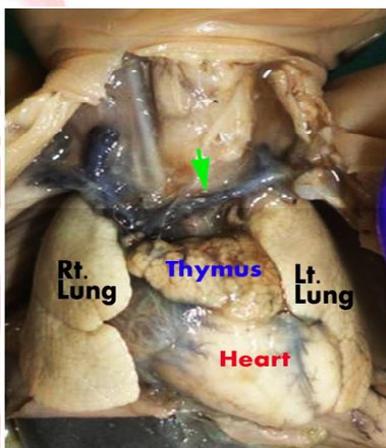


Fig. 6: Symmetrical Shaped Thymus.

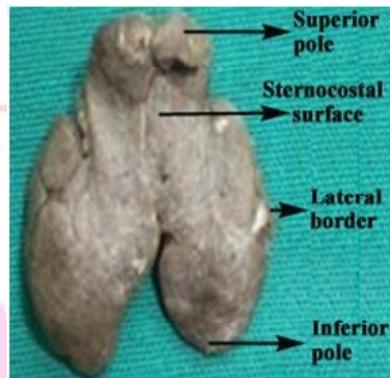


Fig. 7: Pyramidal Shaped Thymus with Right Dominance.



Fig. 8: Triangular Shaped Thymus with Left Dominance.



Fig. 9: Trilobed Thymus Gland.

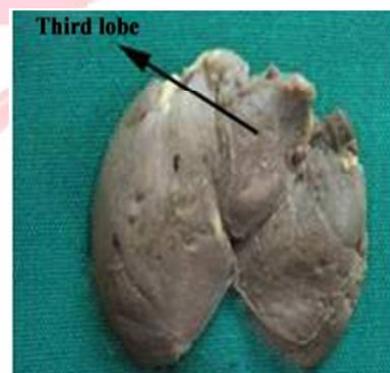


Fig. 10: Oval Shaped Thymus Gland with Single Lobe.



Fig. 11: H Shaped Thymus Gland.



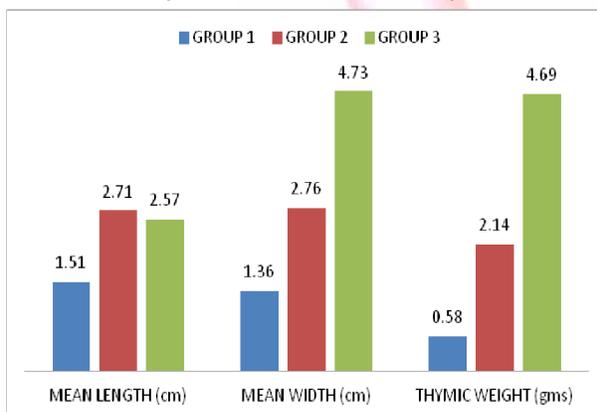
Fig. 12: Irregular Shaped Thymus Gland.



Thymus gland is situated in superior and antero-inferior mediastinum in all the specimens observed in the present study (Fig.4). The gland presented two lateral borders, two surfaces and two poles. The convex sterno-costal surface is related to sternum and costal cartilages. The concave or flat posterior surface is related to brachiocephalic vein in 42 (96.7%) specimens and in 3 (3.3%) specimens the brachiocephalic vein is anterior to the gland (Fig.5). About 60% of glands presented cervical extensions or superior pole extensions up to thyroid gland (Fig.6). Inferior pole extensions were observed in 3 (6.6%) specimens, but not extended up to diaphragm. Most of the thymuses were symmetric (56%) (Fig.6), 31% presented right predominance (Fig.7) and 13% presented left predominance (Fig.8).

The glands are grayish pink to grayish black in colour. About 38 (84.5%) thymus glands were bilobed (Fig.6), 6 (13.3%) were trilobed (Fig.9), and 1 (2.2%) was single lobed (Fig.10). In trilobed thymus the third lobe is observed in between two main lobes of gland (Fig.8). Out of 45 specimens, one (2.2%) is 'H'- shaped (Fig.11), one (2.2%) is oval (Fig.10), two (4.4%) are irregular (Fig.12) and remaining 41 (91.2%) were triangular or pyramidal (fig 6) in shape.

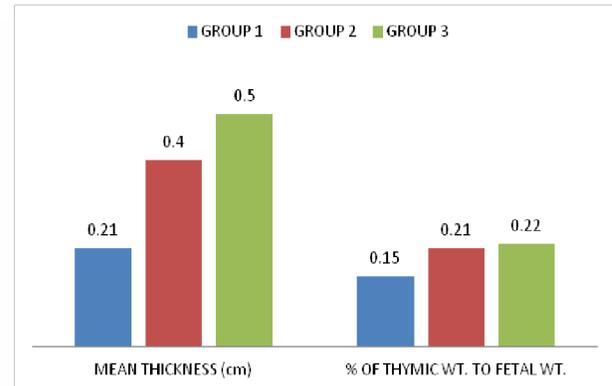
Graph 1: Showing the comparisons between mean Length, Mean Width and Weight.



Graph 1. indicates a two fold increase in the means of all morphometric parameters except length of of thymus gland with increase in gestational age of fetuses. The 'mean length' is greater than 'mean width' of thymus in Group I, where as both parameters were almost similar in Group II and however, the 'mean length' is less than 'mean width' of thymus in Group III. These differences suggests that in the early

gestational ages the thymus gland increases in length wise and then it grows in width wise in the higher gestational age.

Graph 2: Showing the comparisons between mean thickness, thymic weights to foetal weights.



Graph 2. Illustrates that the parameters like 'mean thickness' and mean of 'percentage of thymic weight to the fetal weight' increases significantly from Group I to Group II. But there is no significant increases from Group II to Group III.

Among 45 fetuses 20 were in Group I (12 to 24 weeks) with a mean age of 20 weeks. The weight of fetuses in this group ranges from 60 to 560 grams with mean weight of 318 grams. The 'mean' length, width and thickness of the thymus gland inn group I were 1.51, 1.36 and 0.21 respectively. The mean length was higher than mean width of thymus gland in this group. The mean weight of thymus gland in this group is 0.58gms with a range of 0.07 to 2.53 grams and the mean of 'percentage of thymic weight to fetal weight' is 0.15% with a range of 0.4 to 0.45%.

Out of 45 fetuses, 22 were in group II (25-35 weeks) with a mean age of 29 weeks. Their weights varied from 280 to 1500 grams with a mean of 959 grams.

The 'mean' length, weight and thickness of thymus glands were 2.71, 2.76 and 0.4 cms respectively in which the 'mean length' is less than 'mean width' of thymus for this group. The 'mean weight' of thymus in this group is 2.14 grams with a range of 0.22 to 5.12 grams and mean of 'percentage of thymic weight to fetal weight' is 0.21% with a range of 0.05 to 0.39%.

Out of 45 fetuses we obtained, 3 were in this group (>36 weeks) with gestational age from 36 to 40 weeks. Weight of fetuses ranges from 1400 to 2500 grams with mean weight of 2033 grams.

The 'mean' length, width and thickness of the thymus glands were 2.57, 4.73 and 0.5 cms respectively. However the 'mean length' of thymus gland is lesser than 'mean width' of thymus gland in this group. The mean weight of thymus gland in this group is 4.69 grams with a range of 2.01 to 7.28 grams and the mean of 'percentage of thymic weight to the fetal weight' is 0.22% with a range of 0.14 to 0.29%.

As all the parameters significantly correlated with gestational age of fetuses, each parameter is categorized and compared according to gestational ages.

DISCUSSION

All the 45 human fetal Thymus glands in the present study were located in the superior and anteroinferior mediastinum as mentioned in the literature. Because of irregular shape and ectopic thymus, the external morphology of thymus (surfaces and borders) is rarely mentioned in the literature. Thymus glands were extending from root of the neck up to the 3rd or 4th costal cartilage as mentioned in literature [2, 4]. In 3 (3.3%) cases the thymus gland was behind innominate vein (brachiocephalic vein). Though cases of thymus behind innominate vein were reported in literature [2, 3] their percentage incidence was not available. This type of relation between Thymus gland and brachiocephalic vein shows clinical importance during thymectomy. Eleven types of cervical extensions were reported in literature [3] but in the present study only superior and inferior pole extensions were observed.

Other variations of thymus glands such as ectopic thymus, accessory nodules, thymus above thyroid, feathery margins, thymus extension up to diaphragm were also mentioned in literature [3,10] but such variations were not observed in the present study. In the present study we observed that the Thymus Glands are "grayish pink" to "grayish black" in colour which is similar to the observations of standard text book Gray's anatomy [2].

The percentage incidence of number of lobes observed in the present study were compared with that of Krishnamurthy and Subhadra devi [3] on a large sample of similar south Indian population of a wide age range in Table.1.

Table 1: Percentage comparison on number of lobes of Thymus Glands.

S.No.	No. of Lobes	present study	Dr. krishnamurthy & Dr. subhadra devi 2012
1	Two lobes	89.50%	74%
2	Three lobes	13.30%	13%
3	Four lobes	0%	13%
4	Single lobe	2%	0%

Table 2: Percentage incidence of symmetry of thymus glands.

S.No.	Symmetry	Present Study	Yekler's study
1	Symmetric	56%	54%
2	Right predominance	31%	11%
3	Left predominance	13%	35%

Table 3: Comparison of morphometric parameters between the present study and that of Niurka's study (2010).

S.No.	Parameter	percentage incidence	
		Niurka's study (2010) Number: 147	Present study (2012) Number: 45
1	LENGTH		
	<4 cm	78.9	97.6
	4 - 6 cm	19.1	2.4
	>6cm	2	0
2	WIDTH		
	<2cm	46.9	55.5
	2 - 5cm	53.1	44.5
	>5cm	0	0
3	THICKNESS		
	<0.5 cm	89.1	88.8
	0.5-0.10cm	9.4	11.2
	>0.10cm	1.4	0
4	WEIGHT		
	< 5gr	78.9	91.2
	5-10gr	14.3	8.88
	>10gr	6.8	0

The percentage of bilobed is higher in the present study when compared to that reported in literature [3]. In the literature 13% incidence of four lobes were mentioned [3] but a thymus with four lobes were not observed in the present study. A 2% incidence of single lobed thymus was

observed in the present study which was not reported in literature [3].

The percentage incidence of gland symmetry was compared with Yekeler's study in Table.2 [7]. The percentage incidence of symmetric glands were equal to that stated by Yekler. Higher percentage incidence of right predominance was observed in the present study when compared to that of Yekler et.al., [6].

There is increase in all morphometric parameters with increase in gestational age of fetus. Comparison between the percentage incidence of morphometric parameters like length, width and thickness of the thymus glands between Niurka et.al [5] study and present study in Table.3 illustrates that percentage incidence of morphometric parameters are similar in both studies but there is difference in the individual percentage incidence of morphometric parameters. This difference can be due to a smaller sample in the present study when compared to that of Niurka et.al.,[5].

In the present study the percentage incidence of less than 5gms weight was greater than that of Niurka et.al [5] and the percentage incidence between 5-10 gms being less than that of Niurka et.al. and no case of more than 10 gms weight.

There is no scientific information about "percentage (%) of thymic weight to fetal weight" in the literature. Mean of "% of thymic weight to the fetal weight" is 0.15%, 0.21% and 0.23% respectively for group I, II and III in the present study. From the present study it can be concluded that thymus gland is 0.2 to 0.25% of the total body weight of fetus.

CONCLUSION

Morphological variations of thymus gland have to be considered in thymectomy. In addition to anthropometric parameters of fetus, thymus morphometric parameters also show significant relation to the gestational age of foetuses. Thymic morphometric parameters in relation to gestational age can be used as reference values in imaging studies in the prenatal stage and in initial perinatal system immune and developmental follow-up, in order to prevent infection in this period of life that can lead to death.

Conflicts of Interests: None

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How to cite this article:

S. Havila Hasini, Subhadra Devi Velichety, K. Thyagaraju, K. Jyothirmayi, Ch. Jaipal. MORPHOLOGICAL FEATURES AND MORPHOMETRIC PARAMETERS OF HUMAN FETAL THYMUS GLANDS. Int J Anat Res 2014;2(1):202-07.