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Human Fetal Thyroid Gland: A Morphological & Histological Study

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ABSTRACT

Introduction: the thyroid gland is the first endocrine gland to develop by 24 days after fertilization. It regulates the basal metabolic rate, somatic and psychic growth. The gland promotes growth and development of the brain during fetal life. The embryogenesis of the thyroid gland is important but dealt less in the literature. Therefore, our study aimed to evaluate the morphological and histological features of the thyroid gland in fetuses.

Materials and methods: 18 fetuses (9 males & 9 females) of gestational ages ranging from 12-36 weeks were used in the study. The weight of the thyroid gland in grams was measured, and the microscopic features were noted. The size of the thyroid follicles and the colloid present in them were measured using image analyzer software.

Results: The fetuses were grouped into three trimesters. The gland was normally bi-lobed connected by an isthmus. However, in one of the fetus, the isthmus was absent. The observation of the histological features revealed that development of the thyroid gland has three stages as Colloid formation stage, folliculogenesis stage, and mature follicular growth stage. These stages were correlated with gestational age. Observations including the first appearance of follicles and follicular colloid as well as the secretory and excretory activities in the gland were made and quantified.

Conclusion: the present study provides an insight of the morphological and microscopic alterations during the embryogenesis of the thyroid gland. It will further be useful to understand the anatomical and histopathological changes in the disorders of the thyroid gland.

Keywords: Thyroid gland; Fetuses; Histomorphology; Histogenesis.

Introduction

The thyroid gland is the first endocrine gland to develop in embryonic life by about 24 days after fertilization. It is a gland which is bi-lobed and is mainly developed from thyroglossal duct as a thickening in the floor of the primitive pharynx. The parafollicular cells of the gland are derived from fourth & fifth pharyngeal pouches (MOORE and PERSAUD, 2003; BOYD and MOSSMAN, 1978). Each lobe of the thyroid gland is located on either side of the trachea, below the larynx, in the lower neck. The two lobes are connected to each other by isthmus in front of the trachea. Among endocrine glands, thyroid is unique as it stores a large quantity of its hormonal secretion extracellularly as colloid in contrast to other endocrine glands which store minimal quantities intracellularly as secretory granules only. It is the only endocrine gland that depends on the external environment for the raw materials of its hormones. It possesses one of the richest blood flow, being comparable to that of other endocrine glands. The gland promotes growth and development of the brain during fetal life (WILLIAMS, 1995).

The embryogenesis of the thyroid gland is essential but dealt less in the literature (ANUPRIYA and KALPANA, 2016; JYOTHI *et al*., 2012). Also, the quantification of the morphological changes is limited in the available literature. Therefore, our study aimed to evaluate the morphological and histological features of the thyroid gland in fetuses and to quantify them.

Materials and Methods

The present study was conducted on 18 fetuses (9 males & 9 females) of gestational ages ranging from 11-36 weeks in the Department of Anatomy, Kasturba Medical College (KMC), Manipal. The fetuses were procured from the Department of Obstetrics & Gynecology, KMC Manipal. The study was approved by the Institutional Ethics Committee (IEC 827/2016)

Six fetuses of each trimester were included in the study. Fetuses with apparent gross anomalies were excluded.

The thyroid glands in the fetuses were identified, carefully dissected and excised. The glands were weighed and also observed for morphological differences. The tissues were then fixed in formalin and processed for histological study using Haematoxylin and Eosin stain (H&E). The stained slides were analyzed and documented using microscopic images with the help of ImagePro Premier 9.1 (Media Cybernetics,

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Rockville, USA). The length, width and luminal areas of the thyroid follicles were measured. Six follicles in the area of vision were chosen randomly for the measurements, and their mean values were calculated.

The findings were recorded and analyzed using SPSS version 16 (SPSS Inc., Chicago, IL) and the results were expressed in Mean±SEM.

Results

The thyroid glands observed in the fetuses of all the trimesters were usually bi-lobed and connected by an isthmus (Figure 1). However, in one female fetus of the 3rd trimester, (38 weeks) the isthmus connecting the lobes of the thyroid gland was not observed (Figure 2).

In the present study, we have found that the weight of the thyroid gland increased gradually with the increasing age of the fetuses. The average weight of the thyroid glands in the first, second and third trimesters was graphically represented (Figure 3).

The histological features of the thyroid glands were examined under 10x and 40x magnification (Figure 4). The length and width of the thyroid follicle found a gradual increase with the age of the fetuses as seen microscopically. Accumulation of the colloid within the thyroid follicles was distinct only during the 2nd trimester, i.e., in the 5th month of the intra-uterine life. Vascularity of the gland also increased with the gestational age.

Figure 1. Representative image of the thyroid gland showing the gross features

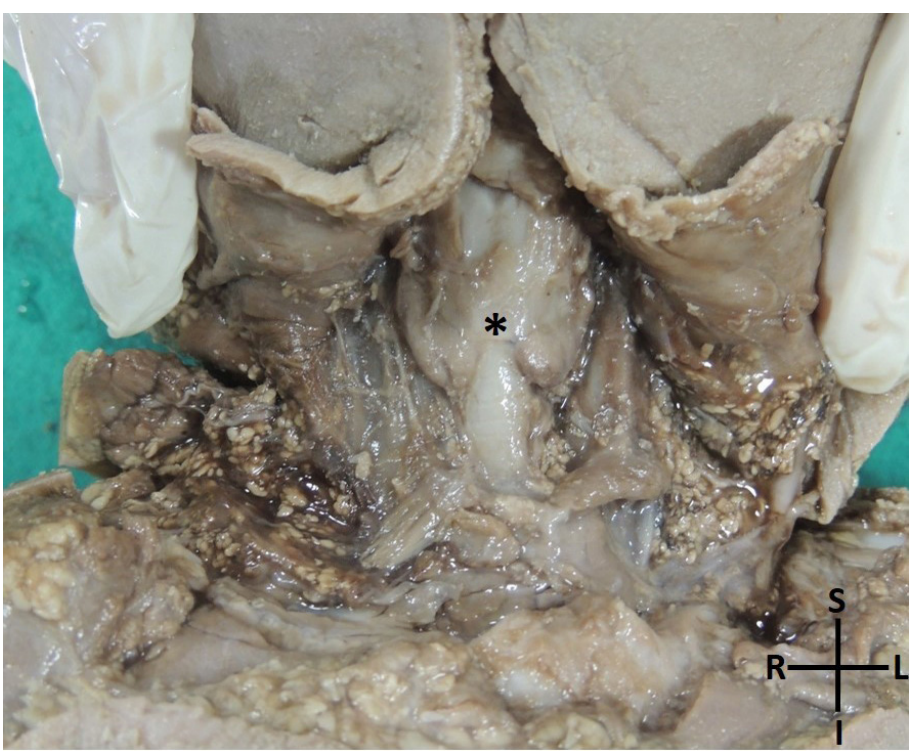

Figure 2. Thyroid gland in situ showing the agenesis of the isthmus (indicated by *) in a full term fetus

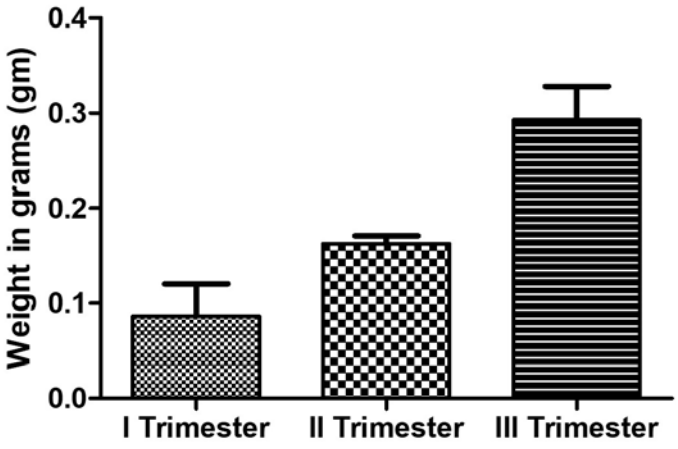

Figure 3. Graphical representation of the average weight of the thyroid glands in the first, second and third trimesters

related to that region. Therefore, the knowledge of the agenesis of the isthmus of the thyroid gland is crucial for the surgeons performing procedures such as thyroidectomy to avoid significant complications (ANUPRIYA and KALPANA, 2016).

The histological studies in the past have revealed that the thyroid gland develops in three stages, i.e., the stage of colloid formation, folliculogenesis, and mature follicular growth. The stages were correlated with the gestational age of the fetuses (BOCIAN-SOBKOWSKA *et al*., 1992; Rao & Patil, 2015). In the present study, the observations including the first appearance of follicles and follicular colloid as well as the excretory activities in the gland were observed and quantified.

In the histogenesis of the thyroid gland, at 12th week, the capsule is thin with a small number of blood vessels.

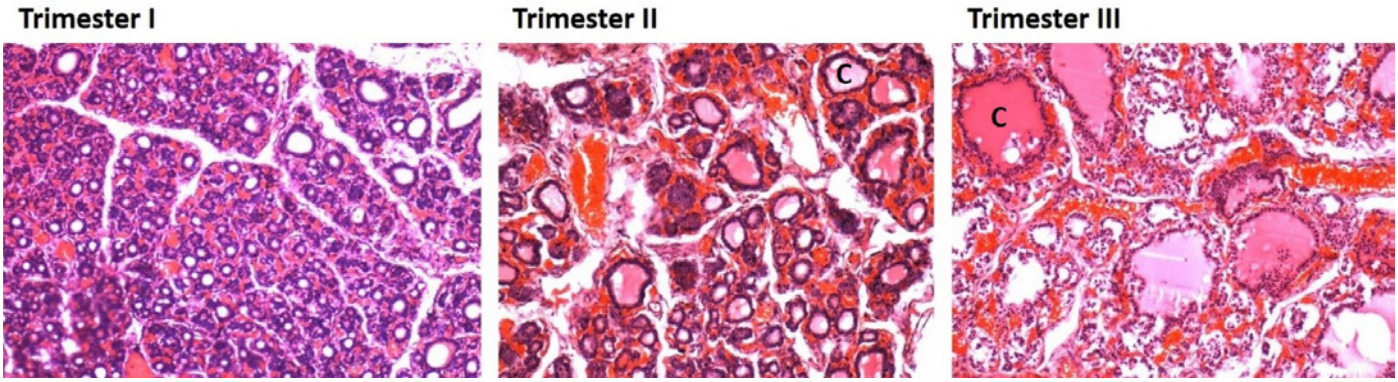

Figure 4. Representative microscopic images of the developing thyroid gland in the first, second and third trimesters. C-Colloid present in the thyroid follicle

The mean length, width and the luminal area of the thyroid follicles were measured and represented trimester wise in table 1.

But as age advances, the capsule became thick, and its vascularity also increased (HAMILTON *et al*., 1972). Similar observations were made in the present study

Table 1. The length, width and the luminal area of the thyroid follicles measured in fetuses.

Period of gestation	Length of the thyroid follicle (mean ±SEM)	The width of the thyroid follicle (mean ±SEM)	Amount of Colloid (mean ±SEM)
Trimester I	37.134±4.289	35.509±3.307	594.147±249.727
Trimester II	64.296±4.738	55.550±6.317	2543.597±442.825
Trimester III	96.660±5.028	79.350±3.961	7161.492±1253.136

Discussion

In the present study, the thyroid gland was observed to be bi-lobed in all the fetuses, except in one case wherein the isthmus connecting the lobes was absent. The absence of isthmus has been reported previously in adult cadavers (VÁZQUEZ *et al*., 2006; LOKANADHAM and DEVI, 2011; MARSHALL, 1895). The agenesis of the thyroid isthmus may be due to an anomaly of embryological development and could be associated with other types of disorganogenesis, such as the absence of a lobe or the presence of ectopic thyroid tissue (VÁZQUEZ *et al*., 2006).

The isthmus of the thyroid gland serves as a prominent landmark for the identification of the vessels

As the gestational age advances, the number of developing thyroid follicles increases. The folliculogenesis is more prominent between 14th – 20th-week stage of fetal thyroid (HAMILTON *et al*., 1972). In the present study, the folliculogenesis was observed by the first trimester, i.e., the end of 12 weeks. The colloid formation was however observed in the second trimester.

The follicles which consist of spheres formed by simple cuboidal epithelium having a lumen filled with a gelatinous substance called colloid (NAYYAR *et al*.,1990). With maturation, colloid formation takes place in the lumen of follicles. During the second stage, the vascularity increases between the follicles.

The diameter of the follicles progressively increases by the third stage (NAYYAR *et al.*,1990; KRATZSCH and PULZER, 2008). In the current study, the length, width and the amount of colloid found a gradual increase during development. The amount of colloid was abundant and distinct in the third trimester. The vascularity between the thyroid follicles also increased considerably from the second to third trimester.

The thyroid follicles first start differentiating at the periphery of the gland. It later extends into the center. It is because the periphery of the gland is more vascular than the center throughout the gestational age of the fetus (GAIKWAD *et al.*, 2012). Similar observations were reported by Potter (1961). The present study also showed an increase in the vascularity at the periphery. It, in turn, indicated greater and early differentiation of the thyroid follicles in the periphery than at the center. Further, it was also observed that the thyroid follicles located at the periphery were of considerably larger dimensions than at the center. Similar observations were reported by Potter (1961).

The presence of colloid in the follicles, its affinity for acidic dyes, clear vacuoles in the colloid and the apically placed nuclei in the epithelial cell are indicative of secretory activity of the follicular cells (MITSKAVITCH, 1957). Our findings coincide with these findings and suggest that the secretory activity of the gland was more during the second trimester.

In most of the follicles, the colloid appeared irregular & eroded at the periphery alongside the follicular cells. It is mainly observed in the active follicles JUNQUEIRA and CARNEIRO, 2009). Ham (1966) reported that the colloid is often seen to have shrunken away from the follicular epithelium and thereby displays an irregular rather than a smooth outline when the gland is active. The following observations were evident during the third trimester as indicated in the present study.

Conclusion

Although most of the studies have focused on the embryogenesis of the thyroid gland, however quantification of the same is rarely dealt. The present study is an attempt for the same.

The present study provides an insight into the histological alterations during the embryogenesis of the thyroid gland. It will further aid in understanding the anatomical and histo-pathological changes in certain disorders of the thyroid gland.

References

ANUPRIYA, A. and KALPANA, R., 2016. Morphological and Histological Features of Human Fetal Thyroid Gland. Int J Sci Stud, vol. 3, n. 10, p.136-140.

BOCIAN-SOBKOWSKA, J., MALENDOWICZ, L. K. and WOZNIAK, W., 1992. Morphometric studies on the development of human thyroid gland in early fetal life. Histol Histopathol, vol. 7, no. 7, p. 415-20.

BOYD, H.W. and MOSSMAN, H.W., 1978. Human Embryology. 4th ed. London: The Macmillan Press Ltd., The Williams and Wilkins Company; p. 232 326.

GAIKWAD, J.R., DOPE, S.A. and JOSHI D.S., 2012. Histogenesis of developing human thyroid. Indian Medical Gazette, p.57-61.

HAM, A.W., 1966. Histology. 7th ed. Philadelphia, Toronto: J. B. Lippincott Company; p. 804-16.

HAMILTON W.J., BOYD J.D. and MOSSMAN H.W.,1972. Human Embryology, 4th ed. London.The Macmillion Press Ltd., The Williams and Wilkins Company, p. 232-326.

JUNQUEIRA, I.C. and CARNEIRO, J., 2009. Basic Histology. 2nd ed. California: Lange Medical Publication; p. 401-3.

JYOTHI, R.G., SANTHOSHKUMAR, A.D., DEEPAK, S.J., 2012. Histogenesis of developing human thyroid. Indian Med Gazet, vol.145, p.57-61.

KRATZSCH, J. and PULZER, F., 2008. Thyroid gland development and defects. Best Pract Res Clin Endocrinol Metab, vol.22, p.57-75.

LOKANADHAM, S. and DEVI, S.V., 2011. Gestational age-related developmental anatomy and histogenesis of human fetal thyroid gland. World J Med Sci, vol.6, p.173 7.

MARSHALL, C.F., 1895. Variations in the form of the thyroid gland in man. J Anat Physiol, vol. 29, no. 234-9.

MITSKAVITCH, M.C., 1957. Glands of Internal Secretion in the Development Bird and Mammalian Embryos. Moscow: A Publication of the Academy of Sciences of Moscow, U.S.S.R.

MOORE, K.L. and PERSAUD, T.V.N, 2008. The Developing Human Clinically Oriented Embryology. 7th ed. USA: Saunders Elsevier; p. 215-7.

NAYYAR, R.P., OSLAPS, R. and PALOYAN, E., 1990. Age related correlation between serum TSH and thyroid C-cell hyperplasia in long-Evans rats. J Exp Pathol, vol.6, p. 89-95.

POTTER E.L., 1961. Pathology of the Fetus and the Infant, 2nd ed. Chicago Year book Medical; p. 10-14, 320-323.

RAO, N.R. and PATIL, B.S., 2015. Histological study of thyroid gland among fetus in different age groups. Int J Biol Med Res, vol.6, n. 2, p. 4957-4962.

VÁZQUEZ, J. P., VERONA, J. G., DE PAZ FERNANDEZ, F. J., and CACHORRO, M. B., 2006. Agenesis of the thyroid isthmus. European Journal of Anatomy, vol. 10, n. 2, p. 83.

WILLIAMS P.L., 1995. Gray's Anatomy, The anatomical Basis of Medicine and surgery, 38th ed. Edingburgh, London: Churchill, Livingstone; p. 1891-1897.

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