

Developmental changes in the morphology of human thyroid gland at different gestational age

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Abstract

Thyroid meaning - thyreos - an oblong shield; eidos - form. In 1656, the anatomist Thomas Wharton named the gland - 'Thyroid' because of its shape resembling a shield. Goitre is one of the common diseases worldwide including Yemen. Due to this fact the thyroid gland became an organ of interest for research workers throughout the world. The aims of the present study are to correlate the weight of fetal thyroid gland with body weight, crown-rump length, and estimated gestational age of fetus. 50 human fetuses (30 Male; 20 Female) of different gestational ages groups were used in the present study. The body weight, crown-rump length and thyroid weight of each of the fetus were recorded. The mean value was calculated for different stages of gestation. The relative weight of thyroid was calculated. The increase in weight of thyroid gland in human fetuses seems to be directly proportional to the increase in the body weight of fetuses, increase in crown-rump length of fetuses, and increase in estimated gestational age. The weight of thyroid at 12th week of gestation was 0.0717 gms. It increased gradually up to 0.517 gms at 28th week of gestation. Thereafter it increased at a faster rate. The weight at 38th week gestation was 1.25 gms. The average percentage relative weight towards term was 0.0445 which was close to that of the newborn (0.049, potter, 61) and adult (0.036).

INTRODUCTION:

Since 1600 BC the Chinese were using burnt sponge and seaweed for the treatment of goitres.

In human beings the thyroid gland is one of the largest and the earliest endocrine organ to differentiate and has an important hormonal role in embryonic development.

The important function of thyroid hormones is to maintain the optimal level of metabolism for the normal functioning of almost all the body cells.

Thyroid hormones stimulate the oxygen consumption of most of the cells in the body, help to regulate lipid and carbohydrate metabolism and are necessary for normal growth and maturation.

The importance of the thyroid gland lies in the fact that it promotes growth and development of the brain during fetal life and the first few years of postnatal life. Iodine deficiency is the single most common cause of preventable

mental retardation and brain damage in the world. It causes enlargement of thyroid (goiter) and decreases production of hormones vital to growth and development.

The Thyroid gland is not essential for life, although its absence causes mental and physical slowing, poor resistance to cold and mental retardation and dwarfism in children.

Aims and Objectives

The aim of the present study is:

To correlate the weight of fetal thyroid with body weight crown-rump length, and estimated gestational age of fetus

Materials and Methods

Collection of Materials

In the present study 50 still born, normal fetuses (30 Male, 20 Female) were obtained with the permission of prof. and head of department of obstetrics and Gynecology,

Government Medical College and Hospital, Aurangabad. For the above purpose the permission was also taken from the Ethical Committee, GMC Aurangabad.

Measurement of External Parameters:

The gestational age, sex, weight, and crown-rump length were studied in detail. The gestational age determined by last menstrual period and crown rump length ranges from 12th week to 36th week.

Weight of fetuses was measured in grams on double pan balance. The crown-rump length was measured by using thread and then a scale.

Dissection, Measurement And Fixation of Thyroid:

Fetuses were carefully dissected. With mid line incision the anterior of the neck was opened. The infra hyoid muscles were separated and the thyroid gland was removed and kept in 10 % formalin for 24 hrs. It was placed in 70% alcohol for 6-8 hours during day, then in 90% alcohol for overnight, and later in xylene for about 30 min for clearing.

Thus the following parameters were noted.

1. CRL of the Fetuses.
2. Weight of the Fetuses in gms.
3. Weight of the thyroid gland in gms.

Results

The present study was carried out on 50 human fetuses (30 Male, 20 Female) of different gestational ages.

The fundamental processes involved in the development are growth, differentiation and metabolism. Growth is increase in spatial dimensions and in weight. Differentiation is increase in complexity and organization. Differentiation may be manifested as an increase in morphological heterogeneity resulting in the assumption of form and pattern and in the appearance of recognizable organs or organ primordia (organogenesis). Metabolism includes the chemical changes in the developing organism. To cover all these aspects of development of thyroid, the following parameters were studied

- Body weight and CRL of fetuses.

The body weight and crown-rump length of each fetus were recorded in gms and mm respectively. When there was more than one fetus from a particular age group, average weight and crown-rump length represented that age group.

By using this data, graphs were plotted. (Graph 1 and Graph 2)

It was observed that there is a gradual increase in weight and CRL from 12th week to 38th week of gestation.

The mean body weight was 108.3 gms and, 3025gms at 12th and 38th week of gestation respectively. (Table 1)

The mean CRL length at 12th week was 111.5 mm and at 38th week was 325mm. (Table 2)

Table 1: Showing average body weight (gms) against weeks of gestational age

Gestational age (Weeks)	Body Weight (gms)
12	108.3
14	140
15	140
16	217
18	266.6
20	444
22	528.3
24	695
26	925
28	1216.7
30	1475
32	1780
34	2175
36	2362.5
38	3025

Thyroid Weight

Weight of thyroid gland was recorded for each fetus. When there was more than one fetus from a particular age group, the average weight represented that age group (Table 3). By using this data, a graph was plotted (Graph 3). It was observed that, the weight of thyroid gland in 12th week of gestational age was 0.0717 gms and it

increases to 0517 gms at 28th week of gestational age. Thereafter, the weight of thyroid gland increases at a faster rate, The weight at 38th week of gestation was 1.25 gms

- Relative weight of thyroid:

The percentage relative weight of thyroid was calculated by the following formula.

Thyroid Weight% Relative weight of Thyroid = Body Weight x 100

The average of percentage relative weight was calculated for a particular age group wherever appropriate. By using this data, a graph was plotted (Graph 4). It was observed that, the relative weight of thyroid is more or less similar through out the period of gestation.

At 12th week of gestation, the percentage relative weight of thyroid was 0.066, then up to 26th wk the average of percentage relative wt of thyroid was 0.06 ± 0.01 . Thereafter it showed more or less similar increase about 0.04 ± 0.01 up to full term. Nearing full term average percentage relative weight was 0.0445.

Table 2: Showing average Crown-rump length (mm) against weeks of gestational

Gestational age (Weeks)	Body Weight (gms)
12	10.2.7
14	111.5
15	113.5
16	120.5
18	151.7
20	165
22	183
24	200.4
26	221
28	250
30	274
32	296.7
34	298.7
36	320
38	325

Table 3: Showing absolute and relative weight of thyroid in different weeks of gestational age.

Gestational age (weeks)	Weight of fetus (gms)	Absolute weight of thyroid (gms)	% relative wt of thyroid
12	108.3	0.0717	0.066
14	140	0.101	0.072
16	217	0.13	0.060
18	266.6	0.166	0.062
20	444	0.290	0.066
22	528.3	0.333	0.063
24	695	0.440	0.066
26	925	0.475	0.051
28	1216.7	0.517	0.042
30	1475	0.575	0.040
32	1780	0.716	0.041
34	2175	1.050	0.048
36	2362.5	1.1	0.048
38	3025	1.25	0.041

Discussion

Human fetal growth is the net result of a complex interplay of genetic, hormonal and growth factor effects.

During intra uterine development of fetus, the thyroid gland is very essential for normal maturation of the central nervous system. Congenitally hypothyroid infants with marked hypothyroxinemia may manifest prolonged jaundice, lethargy, feeding difficulties, umbilical hernia, but the classical symptoms are metabolic derangement, growth retardation and irreversible mental and neurological dysfunction

In the present study, while studying the development of thyroid in antenatal period, the different morphological and histological parameters of thyroid gland were considered.

The study of weight of thyroid gland at different stages of gestation and their proportion to the body weight and crown-rump was undertaken. In the present study body weight of fetuses showed gradual increase from 12th week to 38th week of gestation. These findings were compared with the findings of other workers (Table 4).

Table 4: Showing comparisons of body weight in (gms) of present study with the findings of other workers.

Gestational age in weeks	Moore	Hamilton	Potter and Craig 1976	Schulz 1962	Present study
12	87	57-84	-	-	120.7
14	120	-	-	-	111.5
16	140	61-100	-	-	120.5
18	160	-	-	-	151.7
20	190	101-200	-	227	165
22	210	-	-	-	183
24	230	151-200	209	306	200.4
26	250	-	234	-	221
28	270	201-260	254	-	274
30	280	-	271	-	274
32	300	261-320	284	406	296.7
34	-	-	298	-	298.5
36	340	321-390	324	450	320
38	360	391-450	334	-	327.5

From the above table the body weight reported by Arey (1954) and Schulz (1962), which was up to 36th week and Potter & Craig (1976), which was 26th week were found to be less than the present study. Thereafter it was more or less comparable with them and Gruenwald (1960).

At the same time, when compared with Hamilton (1960), it was greater up to 28th week and comparable thereafter up to 38th week.

However, the findings of our present study were more or less similar to these findings reported by Parulekar (1995).

In the present study the crown-rump length showed gradual increase as the gestational age of fetus increased. These findings were compared with the findings of other workers (Table 5). The crown-rump length reported by

Table 5: Showing comparison of crown-rump length (in mm) of present study with the findings of other workers

Gestational age in weeks	Arey 1954	Gruenwald 1960	Hamilton 1962	Schulz 1962	Potter and Craig 1976	Parulakar 1995	Present study
12	-	-	-	-	-	-	108.3
14	-	-	-	-	38	110	140
16	105	-	73	-	73	200	217
18	-	-	-	-	161	320	266.6
20	310	-	200	312	227	460	266.6
22	-	-	-	-	348	630	528.3
24	640	638	530	7298	361	820	695
26	-	845	-	-	394	1000	925
28	1080	1020	845	1145	-	1300	1216.7
30	-	1230	-	-	1431	1700	1475
32	1670	1488	1940	1778	1900	2100	1780
34	-	1858	-	-	2348	2500	2175
36	2400	2165	3025	2420	2555	2900	2362.5
38	-	2678	-	-	2879	3400	3025

the most, Hamilton and Potter was more or less comparable to the present study.

The findings reported by Schulz were found to be greater than the findings of the present study

Table 6: Showing the comparison of thyroid gland weight (in gms) of present study with the findings of E.L. Potter.

Gestational age in weeks	Weight of thyroid (in gm)	
	E.L. Potter	Present study
12	-	0.0717
14	-	0.101
16	-	0.13
18	-	0.166
20	-	0.290
22	-	0.333
24	0.8	0.440
26	0.8	0.475
28	0.8	0.517
30	0.8	0.575
32	0.9	0.716
34	1.1	0.050
36	1.1	1.1
38	1.3	1.25

In the present study it was observed that the weight of thyroid gland showed gradual increases with the increase in gestational age of fetus (Table 6).

E.L. Potter had reported the absolute weight of thyroid gland from 24th to 38th week of gestational age. He reported constant weight up to 30th week with gradual increase thereafter up to 38th week, Reported weight at 38th week was 1.3 gms. Our study also showed more or less constant weight from 24th to 30th week and gradual increase thereafter. In our study the weight of thyroid gland at 38th week was 1.25 gms.

Williams (2003, 10th edition) has mentioned that the weight of thyroid gland was 80mg at 38th week and 1 to 1.5 gm at term, which coincides closely with our study. In the present study the relative weight of thyroid gland was calculated from 12th week to 38th week of gestation.

At 12th week of gestation, the percentage relative weight of thyroid was 0.066, which remained more or less the same up to 26th week. At 28th week, percentage relative weight was 0.042 which remained almost constant up to 38th week of gestational age. Nearing full term, the average percentage relative weight was 0.0445.

According to Hamilton (1978), the relative weight of the thyroid gland gradually increases until the fourth month (80 mm CRL). At this time the thyroid gland first develops the ability to concentrate iodine. After the fourth month the thyroid maintains an equal growth with body.

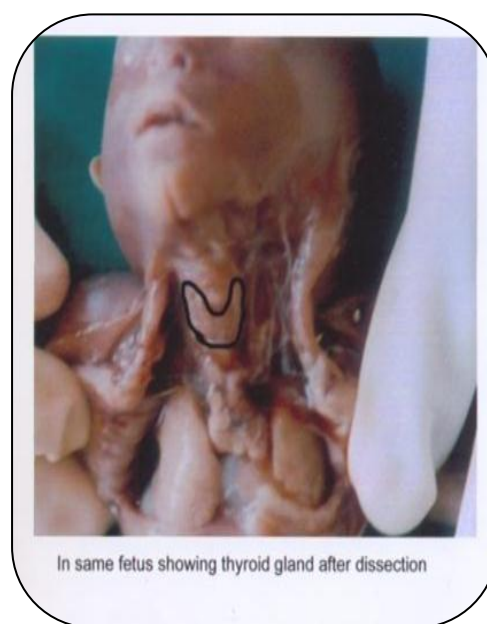
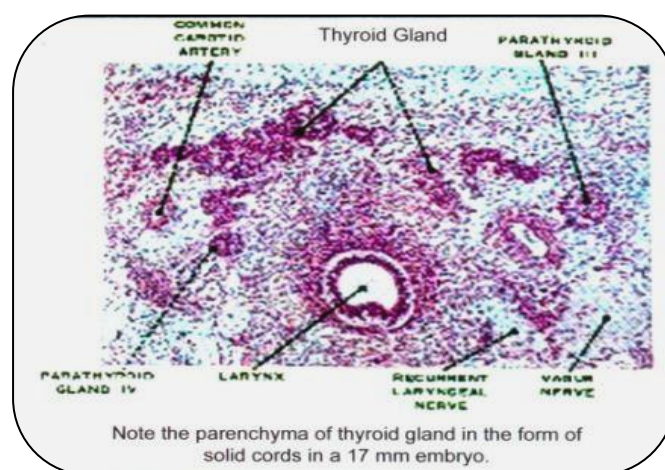
Thomas H. Shepard, Hening J. Anderson, Helge (2005) showed that the relative weights of the thyroid gland gradually increases until fetuses attain a crown-rump length of 80mm This length represents an age of 80 days of gestation and a developmental period which is functionally and histologically very significant

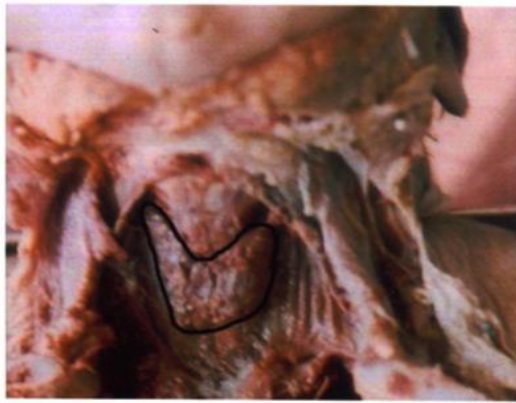
This period (75-85) days of gestation is when the human thyroid first develops the ability to concentrate iodine. After 80mm period the thyroid weight averages

0.0458% of body weight and this average is close to that of the newborn (0.049, Potter,51) and adult (0.036).

Thus the average percentage relative weight of thyroid in our study, 0.0455 was very similar to the finding quoted by the above mentioned workers.

In the present study it was observed that thyroid gland increased proportionally in relation to CRL, body weight and estimated gestational age. This observation was very similar to that reported by Bocoin - Sobkowska J, Malen Dowicz LK (1992 and 1997) and by Thomas Shepard and Henning J. Anderson (2005).





32 Wks fetus showing thyroid gland after dissection

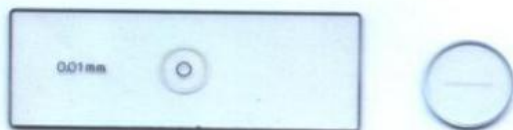


A



B

A & B thyroid gland with trachea of 32 Wks & 16 Wks fetus

Micrometer Scale and Micrometer Eye Piece
To measure the diameter of thyroid follicles

16 Wks fetus with instruments for dissection

Conclusion

1.The increase in weight of thyroid gland in human fetuses seems to be directly proportional to the:-

- Increase in the body weight of fetuses
- Increase in crown - rump length of fetuses.
- Increase in estimated gestational age.

The weight of thyroid at 12th week of gestation was 0.0717 gms. It increased gradually up to 0.517 gms at 28th week of gestation. Thereafter it increased with a faster rate. The weight at 38th week gestation was 1.25 gms

2.The average percentage relative weight towards term was 0.0445 which was close to that of the newborn (0.049, potter, 61) and adult (0.036)

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