
The Effect of Aging on Human Thyroid Gland: (Anatomical and Histological Study)

Sami I. Abdullah*
PhD

Abdul-Jabbar J. Al-Samarrae*
PhD

Abdul-Karim S. Mahood*
PhD

Abstract:

Objectives: To study the effect of aging on human thyroid gland this was investigated anatomically and histologically.

Methods: Twenty thyroid glands from twenty normal male cadavers were examined and divided into five groups each group includes four cadavers: Group (A) aged from 20-29 years, Group (B) from 30-39 years, Group (C) from 40-49 years, Group (D) from 50-59 years, Group (E) from 60-70 years.

Results: Anatomically a negative correlation between process of aging, weight and length of thyroid lobes was found and the peak of weight and length of thyroid lobes present at group B. Histologically, the present study showed a significant negative correlation between age and number of thyroid follicles, follicular and parafollicular cells, while strong positive correlation was found between age and the number of squamous cells of follicular epithelial lining. The basement membrane, the thickness of interstitial tissue also showed a positive correlation with aging.

Conclusions: The weight, length of thyroid gland decreased in approximately proportional level with age. Numbers of thyroid follicles, cuboidal and parafollicular cells are decreased with progressive increase of age. In contrast, the squamous cells are increased with aging process.

Key words: thyroid gland, aging, anatomy of thyroid.

Introduction:

The study of the normal human thyroid gland provides the values needed to interrupt the effects of aging on thyroid gland structures. The word thyroid gland is Greek, and loosely translated to mean " shield gland" ^[1].

The thyroid gland receives 2% of the cardiac output ^[2], and takes up iodide from the blood to produce the hormones thyroxin and triiodothyronine ^[3]. The thyroid gland is one of the largest of endocrine organs, of brownish red color and consists of two large right and left lobes which are united by a narrow thin isthmus and the gland is located in the front of cervical region, anterior to the laryngeal prominence ^[4,5].

The pyramidal lobe is a triangular and slender narrow projection from the midpoint of the upper border of the isthmus ^[5, 6&7]. Keith *et al.* ^[5] & Wahl *et al.* ^[8] showed that approximately 50% of thyroid glands have pyramidal lobe.

The weight of thyroid gland in normal healthy adult is usually about 15 to 20 gm, and each lateral lobe is about 4 cm in length, 2 to 2.5 cm in width, and 1.5 to 2 cm thickness ^[9, 10]. Whereas Schlogl *et al.* ^[11], Hegedus ^[12] and Hoyes & Kershaw ^[13] considered that the weight of adult thyroid gland is about 20 to 30 gm, 5cm in length, 1.5 to 2 cm in width.

The thyroid gland has an abundant blood supply; receiving (80–120 ml) of blood per minute ^[14]. This abundant blood supply is provided from the paired superior and inferior thyroid arteries and some times from the thyroid ima artery. Furthermore, the

collateral vessels from the trachea and esophagus might augment thyroid blood supply ^[15, 16].

The thyroid gland capsule possesses both an outer fascial sheath and an inner thin or loose connective tissue ^[17]. Eroschenko ^[18] explained that the inner layer of thyroid capsule is fibroelastic tissue, which sends septa into the parenchyma of the gland, dividing it into irregular lobes and lobules. In addition, these septa gradually become thinner; they reach all the follicles, separated each follicle from others by fine, irregular connective tissue composed mainly of reticular fibers ^[19].

The thyroid tissue is composed of 20-30 million follicles, and each lobule composed of about 20-40 follicles ^[20,21].

The follicles that vary in diameter about 200-800 um, and depends on the size of a follicle depends on the size and number of follicular cells and the amount of colloid. The follicles are round or oval sacs filled with colloid and lined by a monolayer of low-cuboidal follicular cells, which are surrounded by a basement membrane ^[22, 23].

The follicular epithelium might be simple squamous, cuboidal or low-columnar depending on the state of the activity of the thyroid gland.

The endocrine system was once thought to play a critical role in aging process by virtue of its dominant role in controlling the various organ system of the body ^[24, 25].

The thyroid gland undergoes changes with age and in the course of aging anatomical features and function of the thyroid also undergo age related changes. The thyroid gland in elderly person is

characterized by mild atrophy, increased fibrosis and decreased size of follicles. Functionally there was less peripheral conversion of thyroxin (T4) to triiodothyronine (T3), decreased up take of iodine and over all lower level of thyroxin^[26,27].

The changes show increased interlobular & interfollicular fibrosis, reduction in number and size of follicles^[28,29].

Otoole *et al.*^[30] and Nayyar *et al*^[31] stated that aged thyroid gland has an increased number of parafollicular cells.

Materials & Methods:-

Twenty normal thyroids of adult male cadavers, with age ranging from (20– 70) years were taken from forensic medicine department of Tikrit Teaching Hospital in Salahddin province. The diseased thyroids were excluded from this study.

The age of the cadavers was obtained from the individual's identity card and the accompanied official papers. The cadavers' specimens were divided into five groups according to age and each group was composed of four cadavers as follows:

Group (A): ranged from 20-29 years.

Group (B): ranged from 30-39 years.

Group (C): ranged from 40-49 years.

Group (D): ranged from 50-59 years.

Group (E): ranged from 60-70 years.

Anatomical study:

The most common anatomical approach to the thyroid gland is the skin reflected and structures of the neck procedure by Patrick⁽³²⁾. The excellent exposure of both lobes and their vascular supply, in order to examine and to recognize the followings:

1– The anatomical position of the thyroid.

2– The extensions of the thyroid.

3– The description of arterial blood supply that is done by injection with latex solution.

4– The weight of the right and left lobes of thyroid gland were measured.

5– The length, width and thickness of the right and left lobes were measured.

Histological Study:

Following weighing and gross metrical measurements, the thyroid gland was bisected in a midsagittal plane and 3 small specimens (10×5×5 mm each) were taken. Fixation of the specimens was made using 10% formalin saline for 24 hours. Paraffin tissue blocks were made and (5µm) thickness sections were prepared, mounted and stained with haematoxylin and eosin and Periodic Acid Schiff's stain (PAS)^[33].

The number thyroid follicles, follicular cells and parafollicular cells were counted in all groups; also the microscopical examination involves the descriptive histology the follicles, volume of colloid, follicular epithelium and interstitial connective tissue.

Results were analyzed statistically using correlation test and (ANOVA) test, also variance and standard deviations (mean ± SD) was done^[34].

Results:

Anatomical results:

The thyroid gland is characterized by right and left lobes that connected by isthmus (**Fig 1**). The two lobes extended superiorly from the oblique line of thyroid cartilage to the 5th or 6th tracheal cartilage inferiorly.

A small pyramidal lobe may project upwards from the mid point of the superior border of the isthmus (**Fig 1**); or on the right of it (**Fig 2**). The right lobe of the thyroid gland in 19 cadavers is longer than the left; except one specimen in group (D) showed an equal length of both right and left lobes.

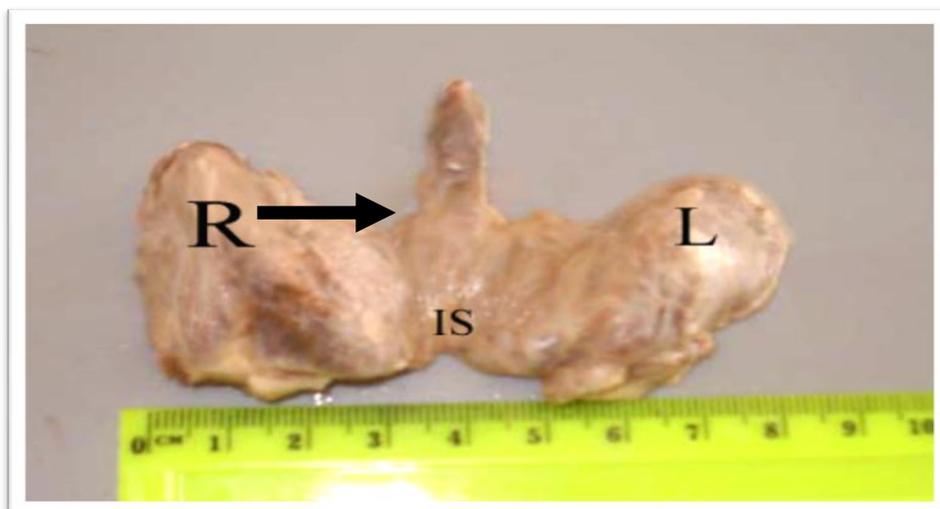


Fig.1. The pyramidal lobe (black arrow) extended from the mid point of isthmus (IS), R= right lobe and L= left lobe.

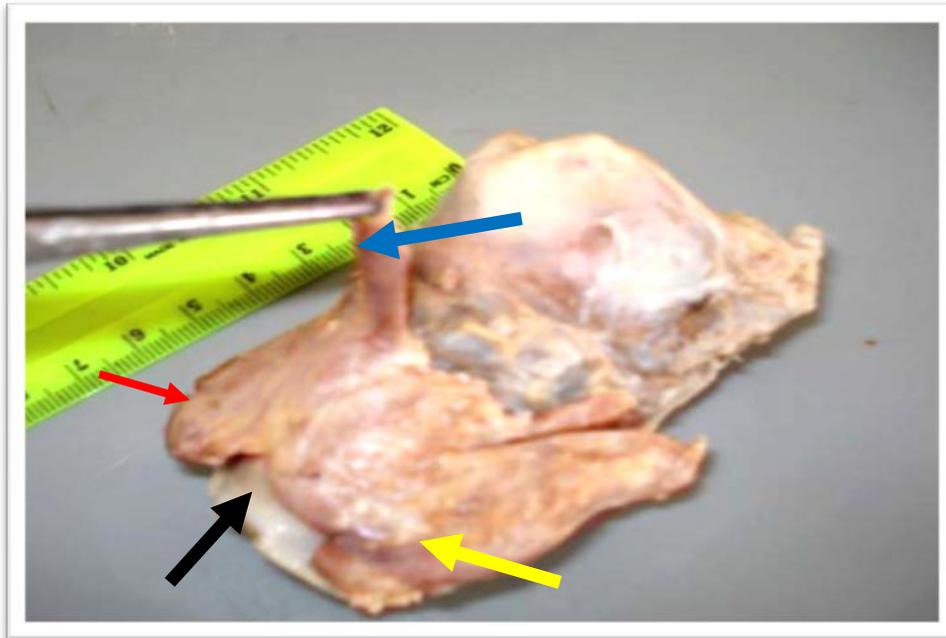


Fig.2.The pyramidal lobe extended near from the right side (blue arrow), right lobe (red arrow), left lobe (yellow arrow) and isthmus (black arrow) of male thyroid gland.

The arterial blood is supplied by paired of superior and inferior thyroid arteries (**Fig 3,4**). Group (C) showed one cadaver that had thyroid ima artery (**Fig 5**).

The weight of thyroid gland in different age groups was shown in (**Table 1**), the peak weight of thyroid gland was in group (B), indicated that

weight of thyroid gland decreased in approximately a proportional level with age.

Table (2) shows the peak length in right and left lobes of thyroid gland in group (B) and there was a negative correlation between the length of thyroid lobes with age progressing.

Table (1): Mean ± standard deviation of the weight of the thyroid gland in different age groups:

Group	Age (Year)	Body height (cm)	Total Thyroid gland weight (gm)
		Mean±SD	Mean±SD
A	20 – 29	171.00± 4.24	22.93± 1.66 ⁿ
B	30 - 39	172.25± 3.89	23.87± 0.78 ⁿ
C	40 – 49	170.00± 6.49	21.81± 2.48 *
D	50 – 60	174.00± 4.56	19.62± 1.19 **
E	60 - 70	168.75± 5.78	18.01± 1.50 **

n= (P>0.05) *= (P<0.05) **= (P<0.01)

Table (2): Means ± SD length of thyroid gland and body height correlated to different age groups:

Group	Body height (wm)	Length of right lobe (cm)	Length of left lobe (cm)
		Mean±SD	Mean±SD
A	171.00± 4.24	2.75± 0.38 n	2.50± 0.84 n
B	172.25± 3.89	3.00± 0.16 *	2.80± 0.67 *
C	170.00± 6.49	2.50± 0.29 *	2.23± 0.49 *
D	174.00± 4.56	2.23± 0.72 *	2.00± 0.81 *
E	168.75± 5.78	2.00± 0.84 *	1.96± 0.65 *

n= (P>0.05), *= (P<0.05)

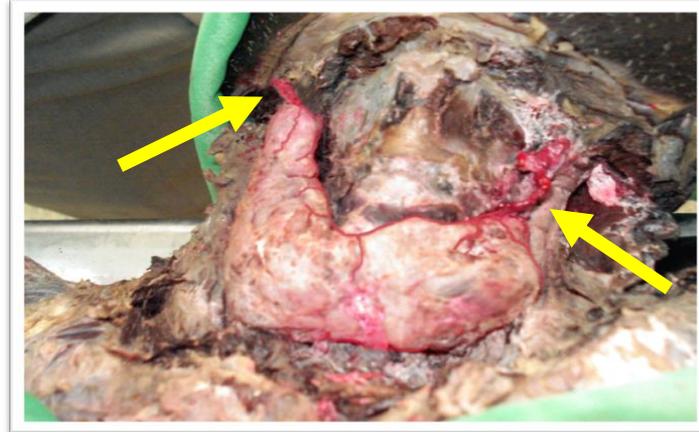


Fig.3. Paired of superior thyroid artery (yellow arrow) distribution on the external surface of thyroid gland.

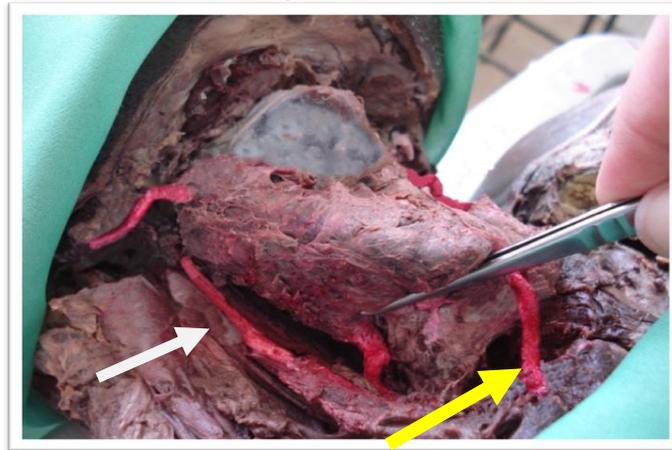


Fig. 4. The inferior thyroid artery (yellow arrow) and common carotid artery (white arrow) behind the right thyroid lobe of thyroid gland.

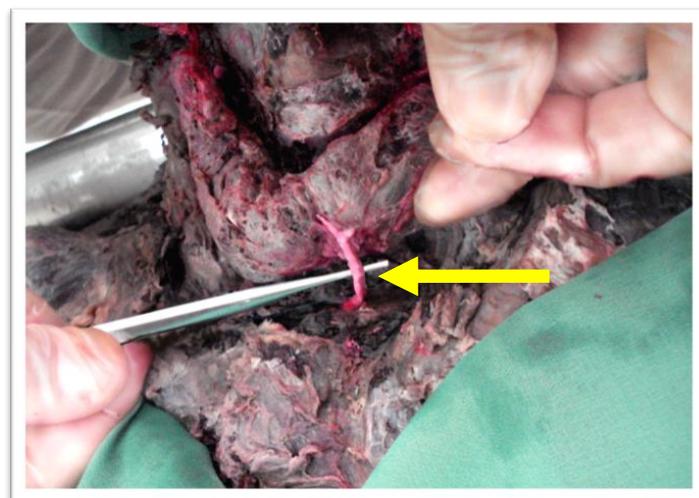


Fig.5. The single small thyroid ima artery (yellow arrow) of male thyroid gland.

Histological results:

Descriptive histology:

In groups (A and B), the thyroid gland was characterized by thyroid follicles which were lined by cuboidal cells, and parafollicular cells between them and a full amount of colloid (Fig 6).

While in group (E) the follicular cells became more flattened, the thickness of basement membrane was increased also the parafollicular cells were decreased in number and the interstitial tissue between follicles was increased (Fig 7, 8).

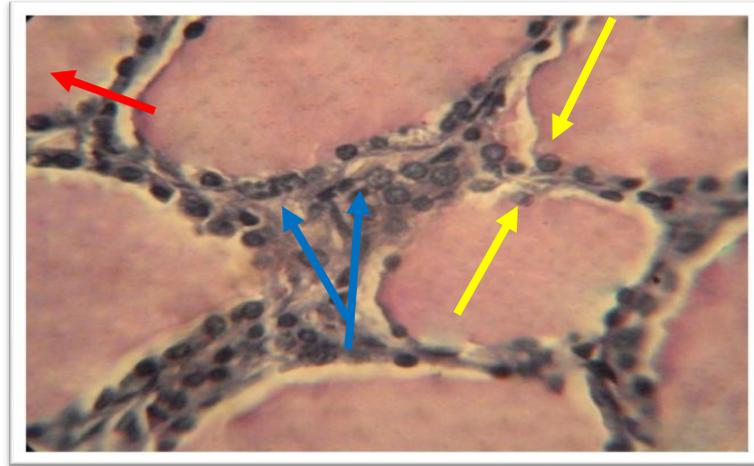


Fig.6. Follicles filled with colloid and follicular cells (yellow arrows) with cluster of parafollicular cells between the follicles (blue arrows) and basement membrane (red arrow) (PAS, 40X).(group A,B)

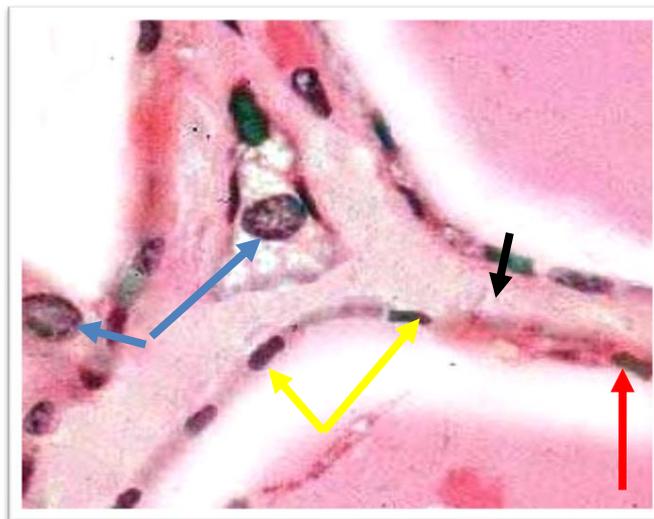


Fig.7. flattened follicular cells in group E (yellow arrows), increased interstitial connective tissue(black arrow) &the thickness of basement membrane(red arrows) and 2 C-cells are shown(blue arrows) (H&E, 100X).

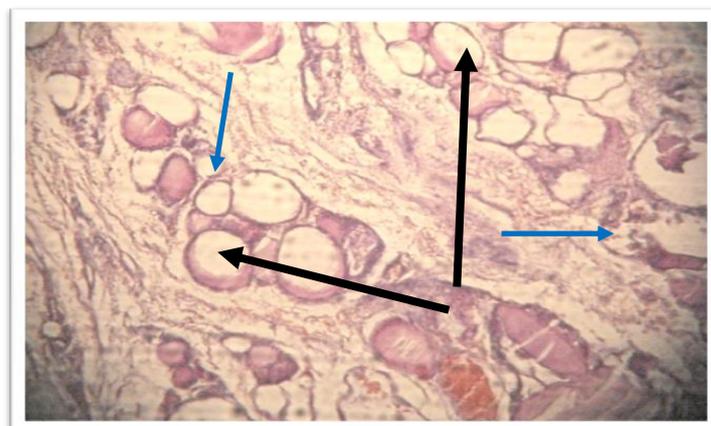


Fig 8. The reduction in the number of follicles and atrophy of the glandular parenchyma with irregular follicles(blue arrows), and proliferation of fibrous connective tissue between lobules and follicles in group E (black arrows) (PAS, 20X).

Morphometric Histology:

Table 3 shows the (mean ± SD) of number and diameter of thyroid follicles of all age groups, the peak value in number and diameter of follicles was at group (B). This value was decreased in groups (C, D & E).

The type and number of follicular cells in this study notice that the cuboidal cells were more frequent among younger age groups compared to

older age groups and vice versa concerning squamous cells.

The (mean ± SD) of parafollicular cells of different age groups were decreasing in relation to age.

Also the basement membrane and the interstitial connective tissue which were significantly increased in correlation to age.

Table (3): Means ± standard deviation numbers and diameter of thyroid follicles of all age groups.

No. of thyroid follicles	Diameter of follicle (µm)
31.12± 3.17n	909.90± 82.18 n
30.71± 2.78n	856.32± 44.38 n
30.68± 2.88n	657.53± 63.27 *
29.12± 2.24*	503.52± 72.51 **
28.22± 2.11*	352.17± 57.06 **

n= (P>0.05) *= (P<0.05) **=(P<0.01).

Discussion:

Thyroid gland of aged individuals is associated with a number of morphological and functional changes. The question of whether and to what extent such changes are dependent on the aging process or on age- associated thyroidial or nonthyroidial diseases is a matter of debate [35].

Concerning the weight of thyroid gland, it has been found that a significant negative correlation existed between age and the thyroid weight, this finding was generally in agreement with Herman & Lacka [36] who mentioned that by age (70) years, the weight of thyroid gland about 20– 30 % less than they do at age (20) years due to atrophy of 40% of follicles and loss of about 30– 40 % of total number of follicles.

The decrease in weight of thyroid gland made present study agrees with Mahne, et al [37] and Avdeenko & Khmel [38] who reported that the maximum weight of thyroid gland was at the age (25 – 35) slightly decreased of at age (40– 49) years and then followed by a considerable weight loss from age of (61) years to age (70) years and onwards.

The present study shows a negative correlation between age and length of right and left lobes of thyroid gland, this result was supported by Keith [39], who mentioned that the maximum length of thyroid gland lobes reaches during the third decade of life and then it decreased (1 - 3 mm) per decade.

This study indicates a negative correlation between age and the number and diameter of thyroid follicles, this finding could be attributed to the shrinkage and collapse of empty follicles in old individual which leads to the loss of about (30 - 40 %) thyroid follicles [22, 28 & 40].

The present study found a significant negative correlation between age process and the number of cuboidal cells and a significant positive correlation between age and number of squamous cells, these result are with agreement with previous findings [41]

&42] which stated a decrease in the number and height of cuboidal cells due to the reduction in the level of thyroid-stimulating hormone.

About the parafollicular cells, the study shows significant negative correlation between the process of aging and the number of these cells, this finding is in agreement with other studies [26 & 43], which stated that parafollicular cells represent (25%) in childhood and in adolescence, while in the adult and elderly age they represent (8– 10%) of thyroid gland cells.

The highly significant positive correlation is found in the present study between process of aging and the interstitial space, the reason that underlies this increase in the interstitial spaces was the interstitial fibrosis which occurs mainly due to age-related increased content of collagen fibers [25, 44].

References:

- 1-Lorrence A.: Thyroid gland: Small but Mighty. North Light, Ear, Head, Throat Clin. 2006; 715 : 735 - 738.
- 2-Malcolm J, Arnold O.: The heart and the thyroid gland. J Thyrolletin. 2000; 8 (2): 503.
- 3-Namba H. , Yamashita S. , Kimura H. , et al : Evidence of thyroid volume increase in normal subjects receiving excess iodide. J Clin Endocrine Metab. 1993; 76: 605 - 608.
- 4-Kynng W. C.: Gross anatomy, Fifth Edition, Lippincott Williams and Wilkins. 2005; PP.352 - 359.
- 5-Keith L. M, Arthur F. D., Anne M. R.: Clinically Oriented Anatomy, Fifth Edition, Lippincott Williams and Wilkins. 2006; PP. 1083 - 1088
- 6-Jenkins G. W., Kemnitz C. P. , Tortora G. J. : Anatomy and physiology from science to life. John Wiley and Sons. 2007; PP. 639 – 645.
- 7-Marios L., William M., Shan T., Brian C.: Levator glandulae thyroideae muscle with three slips. Anatomical Science International. 2007; 27(5) : 31-37.
- 8-Wahl R., Muh U., Kallee E.: Hyperthyroidism with or without pyramidal lobe grave’s disease. Am J Pathol. 1997; 22(7) : 451 – 458.

- 9-Alan S., Lowe J. S. : Human Histology, Third Edition, Elsevier Mosby. 2005; PP. 276 – 279.
- 10-Patricia M. : Endocrine physiology, McGraw – Hill. 2004; PP.73- 83.
- 11-Schlogl S., Werner E., Lessmann M.: The use of three dimensional ultrasound for thyroid volumetry. Am J Thyroid, 2001; 11:569 - 574.
- 12-Hegedus L.: Thyroid size determined by ultrasound, influence of physiological factor and non thyroidial disease. Don Med Bull. 2004; 37(3) : 249 - 256.
- 13-Hoyes A. D., Kershaw D. R. : Anatomy and development of the thyroid gland. Ear Nose Throat J. 1985; 64 : 318 – 326.
- 14-Standring S., Harold E. , Jeremih C. , David J. : Gray's anatomy. The anatomical basis of clinical practice. Thirty ninth edition, Elsevier Mosby. 2006; PP. 560-565.
- 15-Hanatuk L. A. : The thyroid gland. J Clin Ear, Nose & Throat. 2006; 115: 735 – 738.
- 16-Haipeng X. , Wenquan Z. , Shenming W. , Binjie Y : Arterial Embolization: A novel approach to thyroid ablative therapy for grave's disease. J Clin Endocrinol and Metab. 2008; 87 (8): 3583 – 3589.
- 17-Barbara Y., James S.,Tohn H. : Wheater's Functional Histology : A text and color atlas, Fifth Edition, Elsevier Mosby. 2006; PP. 317- 320.
- 18-Eroschenko V. P.: Diflore's atlas of histology with functional correlation, Eleventh Edition, Lippincott Williams and Wilkins. 2008; PP. 395 - 398.
- 19-Junquera L. C., Carneivo J.: Basic Histology, Text & atlas, Eleven Editions, McGraw – Hill. 2005; PP. 411 – 415.
- 20-Harach J. R.: Mixed follicles of human thyroid gland. J Acta Anat. 1987; 129: 27.
- 21-Carlos A., Muro M.: Tumors of thyroid gland: Histologic and cytologic features. Am J of Can. Cont. 2000; 7 (3) : 276 – 278.
- 22-Antongiulio F. , Jeremy C. , Nicolas B. , Monique T.: Age dependant variation of follicular size and expression of iodine transporters in human thyroid tissue . J Nucle Med. 2004; 45(2): 232 -237.
- 23-Dunn J. T., Dunn A. D.: The importance of thymoglobulin structure for thyroid hormone biosynthesis. Biochemistry. 1999; 81: 505.
- 24-Silver A. J., Guillen C. P., Kahl M. J.: Effect of aging on human body. J Am Geriatric Soc. 1995;41: 211 – 213.
- 25-Neepa Y., Gloria D., Cathy S., Michael S.: Role of thyroid hormones in human and laboratory animal reproductive health. Birth Defect Res B. 2003; 68: 479 – 491.
- 26-Sirota D. K.: Thyroid function and dysfunction in the elderly: a brief review. Mt Sinai J Med. 1990; 74: 126 - 131.
- 27-Hden S.T. , Brown E.M. , Hurwitz S. : The effects of age and gender on thyroid and parathyroid gland hormone dynamics. Clin Endocrinol Oxf. 2000; 52: 329-338.
- 28-Browen R. , Moussa M. , Swanson J. : Histometry of normal thyroid in man. J Clin Pathol. 1986; 39: 475–482.
- 29-Chahal H.S., Drake W.M.: The endocrine system and aging. J Pathol. 2007; 211(2) : 173 - 180.
- 30-Otoole K., Fenoglio-preiser C., Pushparaj N.: Endocrine changes associated with human aging process. Effect of age on the number of calcitonin immunoreactive cells in the thyroid gland. J Hum pathol. 1991; 9 : 991 - 1000.
- 31-Nayyar R. P., Oslaps R., Paloyan E.: Age related correlation between serum TSH and thyroid C-cell hyperplasia in long-Evans rats. J Exp Pathol. 1990; 6: 89 -95.
- 32-Patrick W. S.: Grant's Dissector. Thirteenth Edition. Lippincott Williams &Wilkins. A Wolters Kluwer Company. 2005; PP.176 – 182.
- 33-Johan D. B., Alan S.: Theory and Practice of Histological Techniques. Second edition. Langman Group Limited, London. 1982.
- 34-Beth D., Robert G. Trapp: Basic and clinical biostatistics. Fourth Edition. New York : Lange Medical Books/ Mc Graw-Hill Medical Publishing Division. 2004; PP. 83 - 154.
- 35-Stefano M., Claudia F., Andera C.: The aging thyroid. J Clin Endocrinol Metab.1995; 16(6): 686 - 694.
- 36-Herman W. A., Lacka K.: thyroid gland and aging process of men. J Pol Merkur Lekarsk. 2006; 20 (117): 345 – 349.
- 37-Mahne A., Haddad G., Alavi A., Houseni M.: Assessment of age-related morphological and functional changes of selected structure of head and neck by computed tomography and magnetic resonance imaging. J Semin Nucl Med. 2007; 37(2):88 – 102.
- 38-Avdeenko L.,Khmel O.: Morphological characteristics of the thyroid of adults from St – Petersburg. J Arkh Pathol. 2001; 63 (4): 22 - 26.
- 39-Keith E. F. : Body growth considerations in age – specific dosimetry. J Health Sciences Research Division. 1993; 8 : 123 – 127.
- 40-Hartoft N., Rasmussen A.,Feldt R., Bock T.: Estimation of number of follicles, volume of colloid and inner follicular surface area in thyroid gland of rats. J of Anat. 2005; 207 (2): 117 – 124.
- 41-Saita E., Hayama S., Kajigaya H., Yoneda K., Taya K.: Histologic changes in thyroid glands from great cormorant in Tokyo, Bay and Japan. J of Wildliff Dise. 2004; 40(4) : 763 – 768.
- 42-Sultana S. Z.,Khan K. M., Rahman M. H. , Khalil M.: Histomrphometric study of thyroid gland of Bangladeshi people . Mymensingh Med J. 2007; 16 (1): 36 – 42.
- 43-Francesco L., Aldo P.: Aging and the thyroid. J Hot Thyroidology. 2005; 18 (1): 1249 – 1252.
- 44-Hosam K. K.: Hypothyroidism in the elderly. Clinical – Griatrics Med. 1999;11: 159 – 169.

*Depart. of Anatomy, College of Medicine Tikrit University**