Pathological Studies On Thyroid Gland Affections In Some Animals

A Thesis presented

By

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1-Introduction

The thyroid gland is the most important endocrine gland for metabolic regulation. It is necessary for growth, metabolism and function of all cells in the body (Mostaghni et al., 2008)

The thyroid glands and thyroid hormones are central to human and animals development. Animal and human studies indicate that thyroid hormones play a role in cardiovascular, nervous, immune and reproductive system development and function. Thyroid dysfunction is associated with numerous morphological, physiological and behavioral disorders. (Salem et al., 1999 and Choksi et al., 2003)

Thyroid hormones plays an important role in regulating the process of growth, lactation, reproduction and general health (Alwan, 2009)

Appropriate thyroid gland function and thyroid hormone activity are considered crucial to sustain the productive performance in domestic animals (growth, milk or hair fiber production). Changes of blood thyroid hormone concentrations are an indirect measure of the changes in thyroid gland activity. Circulating thyroid hormones can be considered as indicators of the metabolic and nutritional status of the animals. Thyroid hormones play a pivotal role in the mechanisms permitting the animals to live and breed in the surrounding environment (Todini, 2007)

Thyroid pathology is a specialist area of pathology. In the thyroid gland, as for other endocrine organs, many aspects of diagnosis are unique to this area of histopathology. (Anderson and McLaren, 2003)
Ultrasonography is a useful diagnostic tool for diagnosis of thyroid gland in human and animals because of superficial location of thyroid gland. In dogs Ultrasonography is used to evaluate origin, location and margination of suspected thyroid tumors. (Bromel et al., 2006)

Diagnosis of hyperthyroidism in animals is based on clinical signs, physical findings and hormonal assay. In hyperthyroid animal hormonal level fluctuated from day to day (Refsal et al., 1991).

Systemic illness has a potential for a great effect on the thyroid function. Thyroid hormones concentrations are frequently decreased in man and animals with severe non-thyroidal illness (Panciera and Refsal, 1994)

Various illness other than those associated with thyroid glands have profound effect on circulating thyroid hormone concentration in animals. Low serum total thyroxin (T4) concentration is a more common response to illness in dogs. Low serum total T4 concentration also is commonly associated with non thyroid illness in cats (Mooney et al., 1996)
**Aim of work:**

This study was planned to study:

1. The incidence, gross as well as histopathology of spontaneous lesions of thyroid glands in different animals (donkey, cattle and dog) in Egypt.
2. The thyrotoxic effect of Propylthiouracil and levothyroxine sodium on the thyroid glands and other organs of goats as an experimental animal model.
3. Thyroid hormonal assay of triiodothyronine (T3) and thyroxin (T4) in both spontaneous and experimental studies.
I- Physiology and function:

Thyrotropin (TSH) is the main physiological agent regulating the thyroid glands. TSH binds to its specific receptor on the surface of the thyrocyte and activates a G protein-coupled mechanism. TSH and cyclic adenosine monophosphate (cAMP) promote thyroid cell proliferation, function, and differentiation (Fletcher and Clarke, 1994 and Behrends et al., 2005).

The thyroid hormones, tetraiodothyronine or thyroxine (T4) and triiodothyronine (T3) act on many different target tissues, stimulating oxygen utilization and heat production in every cell of the body. The overall effects are increasing the basal metabolic rate, to make more glucose available to cells, stimulate protein synthesis, increase lipid metabolism and stimulate cardiac and neural functions. In sheep, marked seasonal variations in thyroid activity and the thyroid hormones plasma concentrations was described with a main effect caused by ambient temperature. Low and high temperatures, respectively, are stimulatory and inhibitory to thyroid activity. Photoperiod also acts on thyroid activity, as peak plasma thyroid hormones concentrations have been recorded during periods of increasing daylength in spring, and minimal levels during decreasing photoperiod in late summer-early autumn, in rams and goats of both sexes. These changes coincide with the end and the onset of the sexual season, respectively (Todini et al., 2006).

Thyroid glands play a critical role in transition between the breeding and anoestrous seasons in the ewe. In Corriedale rams, minimal thyroxin concentration
were observed during summer and early autumn and maximal thyroxin levels were detected during late autumn (Zamiri and Khodaei, 2005)

In seasonally breeding mammals and birds, secretion of thyroid hormones is a permissive requirement for the annual transition to the non-breeding state. Thyroidectomy has been used to maintain reproductive activity in sheep (Saleh et al., 1998)
-Goiter:

Goiter is a clinical term used to describe a non-neoplastic and non-inflammatory enlargement of the thyroid glands. It developed in all domestic mammals, birds and other sub-mammalian vertebrates as a result of hyperplasia of follicular cells. The major mechanisms for the development of hyperplasia were; iodine deficient diet, goiterogenic substances and excess dietary iodide and genetic defects in enzymes or thyroglobulin that involved in biosynthesis of thyroid hormones, this deficiency lead to decrease blood concentration of T3 and T4 and increase secretion of TSH from pituitary gland, resulted in hyperplasia of follicular cells (McGavin and Zachary, 2007)

Although the goiter seems to be well defined at least from clinical point of view, it is virtually impossible to find the precise definition of the opposite side of what should be the normal thyroid as concerns its size, histological structure and namely the level of growth stimulation by the external factors (such as TSH) and intrinsic tissue growth factors. Theoretically, the normal thyroid should be able to cover the requirements of the organism for the hormone in a reasonably large range without being stimulated to grow by any external or internal factors. So far, the search for normal thyroid has been conducted by several ways, by postmortem thyroid weight, by palpation and by ultrasound (Langer, 1999)

The consequences of persisting iodine deficiency are goiter. Causes other than iodine deficiency, such as autoimmune thyroid disease (AIT) have to be considered. The relationships between dietary iodine intake, endemic goiter and prevalence of clinical or subclinical thyroid autoimmunity are controversial. In Greece, cases of Hashimoto’s thyroiditis were reported after salt iodization. In other studies, the prevalence of thyroid autoantibodies are reported to be between zero to 61.6%.11-13 In China, whereas high prevalence of positive antithyroid
antibodies were found in SriLankan after iodine supplementation (Hashemipour et al., 2007)

Endemic Goiter, the best known and easily recognizable form of iodine deficiency, have been recognized for centuries. India is one of the major Endemia of goiter in the world. No state in the country was believed to be free from Iodine Deficiency Disorders (Hazarika and Mahanta, 2004)

Multinodular non-toxic goiter is the most prevalent thyroid pathology characterized by unilateral or bilateral thyroid growth with morphologically and/or functionally transformed follicles and euthyroidism. Beside morphologic variability, lack of hyperstimulation in the majority of the multiplicated follicles is the hallmark of the disorder. Most nodular goiters grow slowly and undergo different morphologic changes, encompassing diffuse hyperplastic enlargement in the early phase, development of large follicles loaded with abundant colloid and with increasing age, formation of functionally autonomous tissue. The pathogenesis of nodular goiter is multifactorial and probably differs from patient to patient. In contrast to the endemic goiter, iodine deficiency is not a primary causal factor. Environmental factors such as natural goitrogen, iodine intake, malnutrition, drugs, stress, pollution or infections, constitutional factors such as female gender and several genetic factors contribute to different degree to the development of nodular thyroid enlargement. Also controversially debated, thyroid-stimulating hormone (TSH) presumably has an important role in the maintenance of thyroid growth and goitrogenesis. The observation that TSH-suppressive treatment may cause a reduction of goiter volume underlines the role of TSH as goitrogen factor (Frilling et al., 2004)
Toxic multinodular goiter is a cause of non-autoimmune hyperthyroidism and is believed to differ in its nature and pathogenesis from toxic adenoma. Toxic multinodular goiter is commonly found in areas of iodine deficiency, in which patients with long-standing nontoxic goiter frequently develop thyrotoxicosis. The term toxic multinodular goiter encompasses a spectrum of different clinical entities, ranging from a single hyperfunctioning nodule within an enlarged thyroid gland having additional nonfunctioning nodules, to multiple hyperfunctioning areas scattered throughout the gland, barely distinguishable from nonfunctioning nodules and extra nodular parenchyma (Tonacchera et al., 1998)

Diffuse hyperplastic (iodine-deficient) goiter resulted from dietary iodine deficiency. It is characterized by marked hyperlasia of follicular cells and depletion of colloid material (Vegad and Katiyar, 2000)

Colloid goiter represented the involutionary phase of hyperplastic goiter. It developed after excess dietary iodide or after requirements of thyroid hormones have diminished as the animal aged. It developed as a result of increased colloid production from hyperplastic follicles with decreased its endocytosis from follicular lumen as a result of decreased T.S.H. concentration (Vegad and Katiyar, 2000 and McGavin and Zachary, 2007)

Increased thyroid volume or goiter is seen in a number of thyroid diseases independent of thyroid function. Thyroid size has mainly been assessed clinically by the presence or absence of a goiter or by ultrasound examination (Hartoft-Nielsen et al., 2005)
The incidence of Hashimoto’s thyroiditis is greater in areas of sufficient iodine intake than in iodine-deficient areas (Fischer et al., 1988).

II- Pathological affections of thyroid glands in different animal species:

1- Equine:

A properly functioning thyroid gland is highly important to the horse’s good health. In adult horses, thyroid dysfunction is generally uncommon. It has been associated with a variety of clinical signs. A definitive diagnosis is often difficult. Many endogenous and exogenous factors can affect thyroid function and sometimes affect test results also. Serum levels of thyroid hormones vary over a wide range, and low baseline levels may be misleading, which may result in many euthyroid horses being diagnosed as hypothyroid. Primary hypothyroidism is due to inadequate production of thyroxine or triiodothyronine from the thyroid gland. Secondary hypothyroidism results from a deficiency of thyrotropin from the anterior pituitary gland. Tertiary hypothyroidism results when insufficient quantities of thyrotropin releasing hormone are produced by the hypothalamus. Hypothyroidism when occurs in foals, can cause irreversible damage (Sellnow, 1999).

Equine endocrine disorders have been recognized for decades. The most common endocrine disorders dealt with today by equine practitioners and owners are pituitary pars intermedia dysfunction (PPID, Cushing’s syndrome), metabolic
syndrome (EMS), insulin resistance (IR) and suspected hypothyroidism (Graves, 2007)

The size of a horse's thyroid gland can certainly be affected by a number of dietary factors. Too much iodine in the ration, as seen sometimes in horses fed kelp (seaweed)-based supplements, might cause thyroid gland enlargement (also known as "goiter"). Paradoxically, the thyroid gland might also enlarge as a result of iodine deficiency. Dietary deficiency of iodine is unlikely to happen. Secondary iodine deficiency might also result from ingestion of excessive calcium. A much more common cause of goiter in mature to older horses is thyroid adenoma, a benign neoplastic state that is very common and typically does not cause any other problems (beyond the swelling). Other types of thyroid cancer are quite uncommon in horses (Johnson, 2005)

Goiter:

Multifocal nodular goiter (adenomatous goiter) occurred in old horses, cats and dogs. The thyroiditis inactive except for cats. In contrast to thyroid adenoma nodular goiter was not encapsulated (Vegad and Katiyar, 2000)

Two cases of goiter in newborn Arabian foals whose mares were supplemented with excess iodine during the final 24 weeks of the pregnancy were described. Six nursing foals and 2 mares were also affected clinically with thyroid hypertrophy (Eroksuz et al., 2004)

Five foals with developmental abnormalities involving the limbs and upper respiratory tract were observed. Foal number 2 had suckled shortly after birth and was found dead the next day. Death was attributed to a fractured femur (thought to
be traumatic in origin) and massive hemorrhage at the fracture site. Foal number 4 was noted to be weak at birth whereas foals number 6 and 7 died with respiratory distress after birth. Myxedema was evident in only one foal. Although all foals had microscopic evidence of hypertrophy and hyperplasia of thyroid follicular epithelium, obvious enlargement of the thyroid glands was noted only in three foals at the time of necropsy. As a general, in newborn foals, thyroid glands which were judged to be normal appeared active but were not hyperplastic. Follicular epithelial cells were cuboidal to low columnar and formed from a single layer at the periphery of each follicle which contained pink-staining colloid. There was considerable variation in follicular size although all were roughly circular in outline. Thyroid glands of foals included in this report had tall columnar epithelial cells and evidence of epithelial hyperplasia characterized by piling up of cells and by the formation of papillary structures which projected into the lumen of the follicle. Follicles were angular rather than circular in outline and only minimal amounts of pale-staining colloid were present (Doige and Mclaughlin, 1981)

ii- Hypothyroidism:

Regulatory control of the thyroid gland in horses is similar to other species. Clinical signs of hypothyroidism in adult horses are minimal. Several drugs, physiologic and pathophysiologival states can cause circulating thyroid hormone concentrations to be low without actual pathology of the thyroid gland. Thus, non-thyroidal factors must be ruled out before a diagnosis of hypothyroidism can be made. Neonatal foals have very high circulating thyroid hormone concentrations, and deficiencies result in significant clinical signs. (Breuhaus, 2011)
Hypothyroidism is the most common type of thyroid gland dysfunction reported in horses. Equine hypothyroidism remains a controversial endocrine disorder because extrathyroidal factors, including the administration of drugs and systemic diseases that affect serum triiodothyronine (T3) and thyroxine (T4) concentrations in horses. Accurate diagnosis of hypothyroidism therefore requires assessment of the hypothalamic-pituitary-thyroid axis (Frank et al., 2002)

iii- Tumours:

Thyroid neoplasms are usually seen in older horse. Benign adenomas are most common and may be more prevalent in mares with endemic goiter (Beech, 1987).

Equine thyroid follicular carcinoma may be accompanied with adenohypophyseal adenoma (Chiba et al., 1987)

The thyroid glands of foals suffered from thyroid hyperplasia grossly appeared normal in size. Histopathologically, there were very few thyroid follicles, which contained a small amount of colloid. Most follicles were lined with hypertrophic vacuolated epithelial cells (Gawrylash, 2004)

2- Bovine species:

i- Goiter:

Marked follicular hypertrophy was considered to be most likely due to iodine deficiency in the calves’ dam. A case of congenital goiter in two calves in Huron country, Ontario was studied. At necropsy the gross finding revealed markedly enlarged thyroid glands. On histopathological examination, the thyroid glands had most follicles lined by hypertrophic epithelial cells with little or no colloid. There was a marked variation in the size of the follicles. The histopathological lesions were similar in both calves (Wither, 1997)
Iodine content of cows’ milk affected the thyroid glands of their newly-born calves. The thyroid gland disorder was detected in 404 of 1355 calves between one and 21 days of age. Enlargement of the thyroid gland was variable, fluctuating from slight deviations to multiple enlargement. The thyroid enlargement complicated the course of parturition, and increased the mechanical pressure on the larynx and trachea of calves, causing severe dyspnoea and death. Arrhythmia and an unstable heart rate were observed in many calves; partial alopecia on the muzzle, thighs and buttocks was observed in 10% of the calves (Kurza et al., 1997).

Microscopic examination of thyroid glands of 300 buffaloes slaughtered at Municipal Slaughter House in Akola was studied. Majority of thyroid glands examined were normal, pathological lesions observed in thyroid glands were as follows. Histopathologically colloid goiter was observed in 68 (11.72%) glands. Colloid goiter was characterized by distention and enlargement of number of follicles with single layered flattened epithelium filled with abundant colloid. Amidst these follicles medium, small and microfollicles were seen which were lined by cuboidal epithelium. In some cases colloid material was also observed to be distributed in the interfollicular spaces. Parenchymatus goiter was encountered in 11 (1.89%) glands. Parenchymatous goiter was characterized by combination of small and large sized follicles with hypertrophy or hyperplasia of follicular epithelium partially or completely occluding the follicular lumen. Some follicles contained scanty basophilic colloid or degenerated or desquamated lining cells. There was proliferation of interfollicular cells and increased vascularity, microfollicles were also observed in some such glands. Fibrosis was observed in 56 (9.66%) of the thyroid. These glands were showed variable sized follicles with increased interfollicular spaces and these spaces were filled with proliferated fibrous connective tissue or smooth tissue. The follicles of such glands were lined
by flat or low cuboidal epithelium and in some follicles lumen were empty. Congestion and haemorrhages was observed in 16 (2.75%) (Shelke et al., 2009)

ii-Tumours:

Thyroid glands from 64 bulls suffered from hyperplastic and/or neoplastic changes in ultimobranchial remnants and in the parafollicular (C) cell system were studied structurally and with immunohistochemical methods. One type of changes was hyperplasia and neoplasia of the ultimobranchial remnants that affected all their epithelial constituents. These included ultimobranchial follicles, cysts and tubules, as well as solid nests formed by basophilic immature cells which were functionally undifferentiated and unreactive with all antisera used. Differentiated follicular cells that formed thyroid follicles and cribriform structures with immunohistochemical evidence of thyroglobulin production were also found. In addition, differentiated light and cytoplasm-rich cells were scattered in the walls of thyroid follicles, ultimobranchial follicles, cysts and tubules as well as in the solid component. They were argyrophilic and reacted with antibodies against calcitonin and somatostatin. The other change was a diffuse or multifocal hyperplasia of the parafollicular (C) cells, present in other parts of the thyroid parenchyma-sometimes with gradual development of sclerotic tumours that had been exclusively formed by these cells (Ljungberg and Nilsson, 1985)

Ultimobranchial thyroid carcinomas in seven slaughtered cows and one bull were found. No abnormal antemortem findings were observed in any of the cattle except cow number 2, which showed an emaciated condition. In seven of the eight affected cattle, inspectors described masses in the anterior cervical region, close to the larynx or trachea. There was no gross description of such mass in cow number 3. Only in cow number 7 there was gross evidence of possible lymph node
metastasis suggested. With the exception of the tumours in cow number one, all tumors were morphologically very similar, consisting of solid sheets and nests of epithelial cells divided by delicate to coarse fibrovascular stroma. Multiple foci of well-differentiated colloid-filled follicles were sparsely dispersed throughout the mass. The solid areas consisted of dense aggregates of cells arranged in small nests separated by fibrovascular stroma. These cells were polygonal to fusiform with finely granular eosinophilic cytoplasm and round to oval centrally placed nuclei. Colloid follicles were lined by cuboidal to columnar epithelial cells with abundant eosinophilic cytoplasm and basally placed oval nuclei. Some follicles were lined by multiple layers of epithelial cells. The tumours were partially encapsulated, and tumour cells invaded the capsule in all tumours. Focally extensive areas of the fibrous stroma were sclerotic, and Congo red stains for amyloid were uniformly negative. Cysts lined by cuboidal epithelium were present in animals number 1, 2, 4, and 5. Blood-filled sinusoids were present in cows number 2 and 8. In addition to the above features, the tumour in cow number one was characterized by fusiform cells with small round hyperchromatic nuclei and neural fibers (Harmon and Kelley, 2001)

Ultimobranchial thyroid tumours, including those that are familial and those that occur concurrent with pheochromocytomas, are a well-known entity in adult bulls. In contrast, thyroid gland tumours in adult cows are considered rare (Harmon and Kelley, 2001)

3- Dogs:

i-Hypothyroidism:
Causes of canine hypothyroidism may be, associated with inadequate mass of functioning thyroid tissue (primary hypothyroidism) in most cases. Most cases of acquired canine hypothyroidism are attributed to the lymphocytic thyroiditis and idiopathic thyroid atrophy, which result in gradual decrease in thyroid function over months to years. Lymphocytic thyroiditis is an immune-mediated destruction, which may involve humoral and cell-mediated components. Secondary hypothyroidism caused by a failure of the adenohypophysis to secrete thyrotropin [TSH]. Tertiary hypothyroidism has not been documented in the dog (Frank, 2006)

The causes of canine hypothyroidism are varied, but most cases result from irreversible acquired thyroid pathologic changes and only a small proportion arise from congenital anomalies of the thyroid gland or pituitary. At least half of primary thyroid failure is a result of immune-mediated thyroiditis. Serum antibodies against thyroid components are common in thyroid pathologic conditions and dysfunction (Graham et al., 2007)

Hypothyroidism in dogs usually results from a progressive destruction of the thyroid, associated with either lymphocytic thyroiditis or idiopathic atrophy. Both syndromes seem to occur with approximately equal frequency. Lymphocytic thyroiditis, which resembles Hashimoto's thyroiditis in humans, is probably an autoimmune disease, and patients often show thyroid autoantibody titers in circulation (Kemppainen and Clark, 1994)

Primary hypothyroidism is common in adult dog, rarely developed in dogs less than one year old. Either thyroid glands digenesis or congenital defect in thyroid hormone synthesis may cause juvenile onset of primary hypothyroidism in dogs (Greco et al., 1985)
Postmortem examination of a dog suffered from hypothyroidism revealed a marked atrophy of both thyroid lobes. Histopathological examination of the thyroid revealed marked atrophy with focally extensive fibrosis, fatty replacement of normal thyroid tissue and patchy infiltrates of lymphocytes within the connective tissue of the gland (Blois et al., 2008)

Diagnosis of hypothyroidism in dogs can be challenging. Determination of total serum T4 concentration is accepted as the primary screening test for the disease. Low serum T4 concentration is intuitively suggestive for hypothyroidism. However it is well-known that low T4 concentration is encountered in euthyroid dogs with various non thyroid illness. Therefore TSH stimulation test is still considered the most accurate test (Boretti et al., 2006)

A case of juvenile hypothyroidism was studied in a dog. At necropsy, both thyroid lobes were flattened and small. Microscopically, the thyroid showed loss of glandular tissue parenchyma and relatively prominent C-cells. Thyroid follicles varied in size and most of them were markedly small, parenchyma was replaced by adipose tissue along its periphery (Greco et al., 1985)

Neonatal transient hypothyroidism in two whippet puppies aged 10 weeks was observed. The condition was caused by iodine deficiency either in the diet solely or in combination with a partial peroxidase defects. Goiter developed in the puppies fed giblets and poultry meat. Ultrasonographic examination demonstrated enlarged thyroid glands. Histopathological examination revealed hyperplastic epithelial cells of the thyroid glands. The clinical condition improved within two months after the diet was changed to commercial dog food and after oral iodine supplementation (Kolevska et al., 2007)
Hypothyroidism developed in a dog after unilateral thyroid lobectomy and external beam irradiation (48 Gy in 3 Gy fractions) for treatment of functional cystic thyroid adenocarcinoma. Biochemical changes were found within 4 months of completion of radiotherapy, and clinical signs appeared within 7 months. Clinical signs resolved after thyroid hormone supplementation (Kramer et al., 1994)

The dog thyroid glands affected with myxedema appeared small in size. On histopathological examination, mononuclear cells were observed and isolated individual follicles with lymphoplasmacytic thyroiditis were noticed (Atkinson and Aubert, 2004)

There was no difference in prevalence of hypothyroidism or tumors between both sexes of dogs. When 276 Beagles were allowed to live out their full life span (mean, 12 years) in a closed breeding colony, lymphocytic thyroiditis was found in 26.3% of the dogs. This lesion was characterized by lymphoplasmacytic inflammation accompanied by follicular destruction. The thyroiditis was progressive resulting in severe atrophy of follicular tissue, and 44 dogs (15.9%) were diagnosed as hypothyroid dogs at the time of death. Hypothyroid dogs were not given thyroxine replacement therapy. Hypothyroid dogs had an increase risk for thyroid follicular epithelial neoplasia, in particular for follicular adenocarcinomas. Twenty four of the 44 hypothyroid dogs (54.5%) had one or more follicular thyroid neoplasms, whereas only 53 of the 232 (22.8%) euthyroid dogs had similar tumours. Multiple thyroid tumors were present in 14 of the 44 (31.8%) hypothyroid dogs but in only 12 of the 232 (5.2%) euthyroid dogs. One or more follicular adenocarcinomas were present in 15 (34.1%) of the hypothyroid dogs but in only 16 (6.9%) of the euthyroid dogs (Benjamin et al., 1996)
ii-Hyperthyroidism:

Hyperthyroidism in dogs may be associated with thyroid adenoma; the cervical mass was firm and freely movable within the subcutaneous tissue. The mass was cystic, dark red and easily dissected from surrounding tissue. The right lobe appeared normal. Histological examination of the mass revealed a well circumscribed cystic mass that consisted of narrow rim of well differentiated thyroid follicular epithelium surrounding a central lumen which filled with hemorrhage, esinophilic debris and cholesterol clefts. The follicular cells were arranged in form of small acini, the epithelium was divided into layers by a dense fibrous connective tissue with presence of mineralization. Hepatic findings were non specific and was centrilobular fatty change and mild hepatocellular necrosis (Lawrence et al., 1991)

Two years old spayed female, mixed breed dog suffered from hypothyroidism was studied. Physical examination revealed dull hair coat with mild seborrhoea sicca and an irregular cardiac rhythm. An electrocardiogram identified sinus rhythm with a heart rate of 140 bpm and a left anterior fascicular branch block pattern; also, cardiac ultrasound revealed normal cardiac dimensions with no valvular insufficiencies. A well circumscribed (1.47 x 1.40 cm) mass attached to the infundibular right ventricular surface, proximal to the pulmonary valve was identified. A 99mTc-pertechnetate radionuclide scan showed technetium uptake by the intracardiac mass, without evidence of thyroid gland activity (Olson et al., 2007)

iii- Tumours: