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LITERATURE REVIEW

Thyroid hemiagenesis: description of two clinical cases, anatomical review, and critical synthesis of the literature

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Abstract

Introduction: Thyroid hemiagenesis (THA) is a rare congenital thyroid condition in which one of the lobes of the gland fails to develop. The etiology remains uncertain, with the main hypotheses suggesting genetic alterations in thyroid embryogenesis associated with failure of the gland to descend to its final position. Additionally, the condition may be present in both asymptomatic and euthyroid patients, as well as in those with thyroid diseases such as hyperthyroidism, nodular goiter, and neoplasia. **Objective:** To critically review the literature on the subject, detailing known aspects of anatomy in THA, and the demographic findings of patients with this condition, while also adding two case reports to the literature. **Methods:** An extensive, systematized review of the MEDLINE database was carried out using the descriptor "thyroid hemiagenesis". A total of 214 related articles up to October 2022 were retrieved. Out of these, 154 described new cases in the literature and contained demographic and epidemiological data of the reported patients. Studies without new case reports, systematic reviews, and those lacking described or available demographic data—rendered inadmissible for this review—were excluded from the analysis. **Results:** Our review identified the following prevalence and characteristics: 520 cases of THA were reported, and in 50 of them, absence of the isthmus also coexisted. Several thyroid conditions and statuses have been associated with hemiagenesis of the gland. **Conclusion:** THA is more prevalent in female, young, and euthyroid patients. Although rare, it is vital for head and neck surgeons to be aware of this possibility, thereby avoiding unnecessary manipulation of the absent thyroid bed and, consequently, preventing complications.

Keywords: thyroid dysgenesis; thyroidectomy; embryology; genetics.

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Introduction

Thyroid hemiagenesis (THA) is a rare congenital thyroid condition in which one of the lobes of the gland develop. The etiology remains uncertain, with the main hypotheses suggesting genetic alterations in thyroid embryogenesis associated with failure of the gland to descent to its final position. Additionally, the condition may be present in both asymptomatic and euthyroid patients, as well as in those with thyroid diseases such as hyperthyroidism, nodular goiter, and neoplasia.

THA has a prevalence of 0.05% to 0.5% in the population, and its diagnosis is generally incidental[1]. This condition is more frequent in women, with a ratio of 7:1[2]; however, this increased prevalence in females may be related to the fact that this group has higher rates of thyroid-related diseases and, therefore, more investigations related to the gland. Lastly, the left side is more commonly affected, accounting for about 86.7% of cases in some studies[3], and absence of the isthmus may also coexist in some cases[4].

THA can be diagnosed through careful physical examination, as well as by ultrasonography, computed tomography, or scintigraphy of the thyroid. On physical examination, on the affected side, it is possible to easily palpate the edge of the trachea, and the sternocleidomastoid muscle is often much closer to the midline, sometimes covering the trachea, and not distant from it, as in the usual symptomatology. Among the imaging examinations, ultrasonography is the one that offers the best cost-benefit ratio for this diagnosis[5].

The objective of this study was to report two cases of THA, their intraoperative findings, as well as detail known aspects of its anatomy. Additionally, a systematic review was conducted, grouping the epidemiological and anatomical data of this condition described in the literature.

Methods

Systematic review

An extensive and systematized review of the MEDLINE database was conducted using the descriptor "thyroid hemiagenesis". A total of 214 related articles were retrieved up to October 2022. Out of these, 154 described new cases in the literature and contained demographic and epidemiological data of the reported patients, and were included in this study, with individual data shown in Table 1. Studies without new case reports, systematic reviews, and those lacking described or available demographic data—rendered inadmissible for this review — were excluded from the analysis.

Table 1. Demographic, pathological, and anatomical characteristics of cases of thyroid hemiagenesis (THA) found in the systematic review.

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Gursoy et al.[6]	12 (20-81)	9F/3M	Hashimoto's thyroiditis (n = 4)	Left hemiagenesis (n = 12)
			Multinodular goiter (n = 4)	
			Toxic adenoma (n = 1)	Absence of isthmus (n = 6)
			Euthyroid (n = 3)	
Velayutham et al.[7]	1 (18)	1M	Subclinical hypothyroidism	Right hemiagenesis and absence of isthmus
				Ectopic suprahyoid and infrahyoid thyroid gland

Captions: F = female; M = male; NB = newborn; n = number; -: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Campennì et al.[8]	1 (36)	1M	Graves' Disease Papillary thyroid carcinoma	Left hemiagenesis
Bhartiya et al.[9]	1 (40)	1F	Euthyroid	Left hemiagenesis Multinodular goiter on the right side
Sasaki et al.[10]	1 (28)	1F	Graves' Disease	Right hemiagenesis
Peña et al.[11]	1 (55)	1F	Euthyroid	Left hemiagenesis
Shaha and Gujarati[12]	1 (30)	1F	Papillary thyroid carcinoma	Right hemiagenesis
Wang et al.[13]	1 (31)	1F	Hashimoto's Thyroiditis	Left hemiagenesis Absence of left parathyroids
Matsumura et al.[14]	1 (35)	1F	Thyrotoxicosis	Left hemiagenesis
Sharma et al.[15]	1 (33)	1F	Lymphocytic thyroiditis	Left hemiagenesis
Isreb et al.[16]	1 (75)	1F	Primary hyperparathyroidism	Left hemiagenesis
Kocakusak et al.[17]	1 (38)	1F	Hyperthyroidism	Left hemiagenesis
Cansu et al.[18]	1 (45)	1F	Graves's Disease	Left hemiagenesis and absence of isthmus
De Sanctis et al.[19]	3 (6-13)	3M	Euthyroid (n=3)	Left hemiagenesis (n = 1) Right hemiagenesis (n = 1) Left hemiagenesis + absence of isthmus (n = 1)
Pizzini et al.[20]	1 (54)	1M	Euthyroid	Left hemiagenesis
Maiorana et al.[21]	12 (11-14)	5F/7M	Euthyroid	Left hemiagenesis (n = 12)
Rajmil et al.[22]	2 (29-50)	2F	Euthyroid	Left hemiagenesis and absence of isthmus (n = 2)
Shabana et al.[5]	6 (6-12)	4F/2M	Euthyroid	Left hemiagenesis (n = 3) Left hemiagenesis + absence of isthmus (n = 3)
Hamburger et al.[23]	1 (14)	1F	Mixed tumor: papillary and follicular carcinoma	Left hemiagenesis
Çitgez et al.[24]	1 (32)	1F	Follicular neoplasm	Left hemiagenesis
Park et al.[25]	1 (32)	1F	Euthyroid	Right hemiagenesis and absence of isthmus

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Buyukdereli et al.[26]	3 (41-59)	1F/2M	Hyperthyroidism (n = 2)	Left hemiagenesis (n = 1)
			Euthyroid (n = 1)	Right hemiagenesis (n = 2)
Chuang et al.[27]	1 (30)	1F	Euthyroid	Right hemiagenesis
				Ectopic sublingual thyroid
Sereke et al.[28]	1 (32)	1F	Euthyroid	Left hemiagenesis
Kartini et al.[29]	1 (59)	1F	Hurthle cell carcinoma	Right hemiagenesis
Schneider et al.[30]	13	11F/2M	Graves' disase	-
			Hashimoto's Thyroiditis	
			Hypofunctional nodules	
			Toxic goiter	
			Nodular goiter	
Mikosch et al.[31]	1 (21)	1M	Euthyroid	Left hemiagenesis and absence of isthmus
Wang et al.[32]	2 (49-60)	2F	Medullary thyroid carcinoma	Right hemiagenesis and absence of isthmus (n = 1)
			Papillary thyroid cancer	Left hemiagenesis (n = 1)
Hsieh et al.[33]	2 (25-48)	1F/1M	Euthyroid	Right hemiagenesis (n = 1)
				Left hemiagenesis (n = 1)
Gandla et al.[34]	1 (20)	1F	Papillary thyroid cancer	Right hemiagenesis
				Absence of upper thyroid vessels ipsilateral to the hemiagenesis
Peteiro-Gonzalez et al.[35]	5 (16-74)	5F	Euthyroid (n = 2)	Right hemiagenesis and absence of isthmus (n = 1)
			Subclinical hypothyroidism (n = 2)	Left hemiagenesis (n = 3)
Sari et al.[36]	4 (9-73)	2F/2M	Hyperthyroidism (n = 1)	Right hemiagenesis (n = 1)
			Subclinical hyperthyroidism (n = 1)	Left hemiagenesis (n = 3)
			Hypothyroidism (n = 1)	Right hemiagenesis (n = 1)
			Euthyroid (n = 2)	
McHenry et al.[37]	7	-	Adenoma (n = 1)	Left hemiagenesis (n = 5)
			Follicular thyroid carcinoma (n = 1)	Right hemiagenesis (n = 2)
			Colloid nodule (n = 2)	
			Graves' disease (n = 2)	
			Simple goiter (n = 1)	

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Karabay et al.[38]	1 (45)	1F	Multinodular goiter	Right hemiagenesis and absence of isthmus
Ferrari et al.[39]	1 (15)	1F	Primary hyperparathyroidism	Left hemiagenesis
Jha et al.[40]	1 (9)	1F	Subclinical hypothyroidism	Right hemiagenesis and absence of isthmus
Suzuki et al.[41]	67 (0-23)	41F/26M	Euthyroid (n = 67)	Right hemiagenesis (n = 12)
				Left hemiagenesis (n = 55)
Kada et al.[42]	1 (48)	1F	Parathyroid carcinoma, secondary hyperparathyroidism	Right hemiagenesis
Szczepanek-Parulska et al.[1]	2 (39-45)	2F	Goiter (n = 2)	Left hemiagenesis (n = 2)
Oruci et al.[43]	1 (66)	1F	Parathyroid adenoma	Right hemiagenesis
Wu et al.[44]	5 (29-89)	4F/1M	Subclinical hyperthyroidism (n = 1), hypothyroidism (n = 1), euthyroid (n = 3)	Left hemiagenesis (n = 5)
Gurleyik et al.[45]	2 (25-49)	1F/1M	Hyperthyroidism (n = 1), Graves' disease (n = 1)	Left hemiagenesis (n = 2), multinodular goiter (F)
Alqahtani et al.[46]	2 (36-40)	1F/1M	Primary hyperparathyroidism to the left side with thyroid papillary microcarcinoma (n = 1), papillary carcinoma (n = 1)	Right hemiagenesis associated with suspicious multinodular left lobe, presence of isthmus, and parathyroid adenoma (n = 1)
				Left hemiagenesis with presence of isthmus and nodule in the right lobe (n = 1)
Yildiz et al.[47]	1 (13)	1M	Goiter	Left hemiagenesis
Chun et al.[48]	1 (1)	1F	Congenital hypothyroidism (n = 1)	Right hemiagenesis
Kirdak et al.[49]	1 (59)	1M	Subclinical hypothyroidism and plunging goiter	Left hemiagenesis
Bosco et al.[50]	1 (50)	1F	Hashimoto's Thyroiditis	Left hemiagenesis and absence of isthmus; parathyroids and inferior laryngeal nerve in the usual location
Ayaz et al.[51]	1 (8)	1M	Euthyroid	Left hemiagenesis, minimal hyperplasia on the right side

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Nsame et al.[52]	1 (23)	1F	Graves' disease with progression to Hashimoto's thyroiditis after use of anti-thyroid drugs	Left hemiagenesis, absence of isthmus
Gurleyik et al.[53]	1 (51)	1F	Hyperthyroidism	Left hemiagenesis, absence of isthmus; toxic adenoma in the right lobe
Sato et al.[54]	1 (64)	1F	Papillary carcinoma	Left hemiagenesis; 1.4 cm tumor on the side of the missing lobe
Reya et al.[55]	1 (21)	1F	Subclinical hyperthyroidism	Left hemiagenesis
Aydogan et al.[56]	1 (38)	1F	Thyroiditis with intermittent thyrotoxicosis	Left hemiagenesis; submandibular ectopic thyroid
Verma et al.[57]	3 (33-41)	3F	Euthyroid	Left hemiagenesis and absence of isthmus (n = 3)
Mikosch et al.[58]	16 (29-71)	13F/3M	Graves' disease (n = 1)	Left hemiagenesis (n = 10)
			Euthyroid (n = 5)	Left hemiagenesis + absence of isthmus (n = 5)
			Nodular goiter (n = 7)	Right hemiagenesis (n = 1)
			Diffuse goiter (n = 2)	
			Hashimoto's thyroiditis (n = 1)	
Korpal-Szczyrska et al.[59]	2 (7-15)	2F	Euthyroid	Left hemiagenesis and absence of isthmus (n = 2)
Ammar et al.[60]	1 (16)	1F	Euthyroid	Right hemiagenesis.
				Mobile, fibroelastic, 1 cm cyst in the left lobe
Baldini et al.[61]	1 (41)	1F	Graves' disease	Left hemiagenesis
Cansu et al.[18]	1 (45)	1F	Graves' disease	Left hemiagenesis and absence of isthmus
Kim et al.[62]	1 (2)	1M	Congenital hypothyroidism	Right hemiagenesis
			Microduplication of 22q11.2	
Szczepanek-Parulska et al.[63]	65 (40.9 ±19.7)	56F/9M	Hyperthyroidism (n = 7)	-
			Hypothyroidism (n = 20)	
			Goiter (n = 18)	
			Euthyroid (n = 28)	

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Wu et al.[64]	1 (48)	1F	Euthyroid	Left hemiagenesis
				Multinodular nodule in the right lobe
Shah et al.[65]	1 (72)	1F	Hypothyroidism	Left hemiagenesis and absence of isthmus
Berker et al.[66]	10 (21-63)	8F/2M	Graves' disease (n = 1)	Left hemiagenesis (n = 7)
			Hashimoto's Thyroiditis (n = 1)	Right hemiagenesis (n = 3)
			Nodular goiter (n = 4)	
			Multinodular goiter (n = 2)	
			Euthyroid (n = 8)	
Cakir et al.[67]	1 (55)	1F	Graves' disease and nodular goiter	Left hemiagenesis and absence of isthmus
Szczepanek-Parulska et al.[68]	2 (10-13)	1F/1M	Hyperthyrotropinemia (n = 1)	Left hemiagenesis (n = 2)
			Goiter (n = 2)	
Yang et al.[69]	1 (26)	1F	Goiter	Left hemiagenesis
			Lingual thyroid	
Chang et al.[70]	2 (50-61)	2F	Euthyroid (n = 2)	Left hemiagenesis (n = 2)
Kroeker et al.[71]	1 (41)	1M	Parathyroid adenoma (hypercalcemia and nephrolithiasis)	Left hemiagenesis
Ruchala et al.[2]	40 (12-79)	35F/5M	Hyperthyroidism (n = 4)	Left hemiagenesis (n = 35)
			Hypothyroidism (n = 10)	Right hemiagenesis (n = 5)
			Euthyroid (n = 26)	
Castanet et al.[72]	22 (2-89)	14F/8M	Hypothyroidism (n = 9)	Right hemiagenesis (n = 16)
			Hyperthyroidism (n = 1)	Left hemiagenesis (n = 6)
			Euthyroid (n = 12)	
Faulkner et al.[73]	1 (31)	1F	Graves' disease	Left hemiagenesis
Burman et al.[74]	3 (41-58)	2F/1M	Graves' disease associated with thyrotoxicosis (n = 1)	Left hemiagenesis (n = 3)
			Euthyroid (n = 1)	
			Primary myxedema (n = 1)	
Russotto et al.[75]	1 (23)	1F	Euthyroid	Right hemiagenesis
Bough et al.[76]	1 (51)	1F	Metastatic thyroid adenocarcinoma	Left hemiagenesis

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Nakamura et al.[77]	1 (28)	1F	Graves' disease with progression to hypothyroidism	Right hemiagenesis
Prakash et al.[78]	7 (8-65)	6F/1M	Toxic adenoma (n = 2)	Left hemiagenesis (n = 5)
			Colloid goiter (n = 3)	Right hemiagenesis (n = 2)
			Multinodular toxic goiter (n = 1)	
			Hashimoto's thyroiditis (n = 1)	
Greening et al.[79]	3 (47-52)	1F/2M	Adenoma (n = 2)	Left hemiagenesis, absence of isthmus (n = 3)
			Papillary adenocarcinoma (n = 1)	
Sakurai et al.[80]	1 (42)	1M	Primary hyperparathyroidism	Right hemiagenesis
Tiwari et al.[81]	1 (37)	1F	Euthyroid	Right hemiagenesis, absence of isthmus
Lee et al.[82]	1 (69)	1F	Papillary thyroid cancer and adenomatous hyperplasia of the right lobe	Left hemiagenesis
Philip et al.[83]	1 (50)	1F	Graves' disease with thyrotoxicosis	Right hemiagenesis
Melnick et al.[4]	4 (29-58)	2F/2M	Euthyroid (n = 4)	Left hemiagenesis (n = 4)
				Absence of isthmus (n = 2)
Huang et al.[84]	1 (47)	1F	Papillary thyroid cancer and ectopic thyroid tissue	Right hemiagenesis
Ozgen et al.[85]	1 (29)	1F	Graves' disease with ophthalmopathy	Left hemiagenesis
Nayak et al.[86]	1 (45 days)	1F	Lingual cyst	Left hemiagenesis, absence of isthmus
Shechner et al.[87]	2 (33-35)	2F	Graves' disease (n = 2)	Left hemiagenesis (n = 1)
			Thyrotoxicosis (n = 1)	Right hemiagenesis (n = 1)
Meringolo et al.[88]	1 (64)	1F	Subclinical hypothyroidism with progression to Graves' disease and orbitopathy	Left hemiagenesis
Liu et al.[89]	1 (43)	1F	Graves' disease	Left hemiagenesis, absence of isthmus
			Thyrotoxicosis	
Aslaner et al.[90]	1 (44)	1F	Multinodular goiter	Left hemiagenesis

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Mydlarz et al.[91]	1 (55)	1F	Primary hyperparathyroidism (adenoma)	Left hemiagenesis
Ng TT et al.[92]	1 (37)	1M	Euthyroid	Parapharyngeal cyst on the right side
				Right hemiagenesis
Hervás et al.[93]	1 (45)	1M	Graves' disease	Right hemiagenesis
Papi et al.[94]	1 (42)	1F	Euthyroid	Left hemiagenesis, absence of isthmus
				Pseudo-nodules
Stagi et al.[95]	1 (12)	1F	Williams syndrome	Left hemiagenesis
Nebesio et al.[96]	1 (10)	1F	Down syndrome	Left hemiagenesis
			Congenital hypothyroidism	
			Graves' disease	
Borges et al.[97]	1 (-)	1F	Congenital hypothyroidism	Left hemiagenesis
Lee et al.[98]	1 (44)	1F	Graves' disease	Left hemiagenesis
Eroglu et al.[99]	1 (27)	1F	Hyperparathyroidism	Right hemiagenesis
				Right parathyroid adenoma
Karatag et al.[100]	1 (59)	1F	Papillary carcinoma	Left hemiagenesis
Léger et al.[101]	3 (-)	1F/2M	Euthyroid (n = 3)	Left hemiagenesis (n = 2)
				Right hemiagenesis (n = 1)
				Absence of isthmus (n = 2)
Abbassi et al.[102]	2 (4-11)	1F/1M	Euthyroid	Left hemiagenesis (n = 2)
Woods et al.[103]	1 (31)	1F	Hyperparathyroidism	Left hemiagenesis
Khatri et al.[104]	1 (41)	1F	Papillary adenocarcinoma	Right hemiagenesis
Hsu et al.[105]	1 (NB)	1F	Congenital hypothyroidism	Right hemiagenesis
				Ectopic sublingual thyroid
Friedman et al.[106]	6 (18-67)	4F/2M	Toxic goiter (n = 4)	Left hemiagenesis (n = 5)
			Hyperthyroidism (n = 2)	Right hemiagenesis (n = 1)
Konno et al.[107]	1 (38)	1F	Goiter	Left hemiagenesis (absence of left thyroid arteries on angiography)
			Right aortic arch	
Zangeneh et al.[108]	1 (31)	1F	Graves' disease	Left hemiagenesis

Captions: F = female; M = male; NB = newborn; n = number; -: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Kirmızibekmez et al.[109]	12 (2-3 months)	-	Congenital hypothyroidism (n=12)	Left hemiagenesis (n = 5)
				Right hemiagenesis (n = 7)
Jain et al.[110]	1 (17)	1F	Goiter	Left hemiagenesis
Golinger et al.[111]	1 (52)	1F	Euthyroid	Left hemiagenesis (cystic, enlarged, right lobe and thin isthmus)
Cerqueira et al.[112]	13 (children)	6F/7M	Congenital hypothyroidism(n=13)	-
Kebapçilar et al.[113]	1 (43)	1F	Graves' disease	Left hemiagenesis
			Hypercalcemia	
Rosenberg et al.[114]	1 (3)	1M	Euthyroid	Left hemiagenesis
Hsu et al.[115]	2 (NB)	2F	Congenital hypothyroidism (n=2)	-
Duarte et al.[116]	5 (6-14)	2F/3M	Euthyroid	-
Shibutani et al.[117]	1 (58)	1F	Subacute thyroiditis	Right hemiagenesis
Saydam et al.[118]	1 (25)	1F	Euthyroid	Left hemiagenesis
Ruchala et al.[119]	1 (49)	-	Hashimoto's thyroiditis with progression to Graves' disease and progression to hypothyroidism after combined radiotherapy and iodine therapy	Left hemiagenesis
Folsom et al.[120]	1 (18)	M	Nodular hyperplasia	Left hemiagenesis (isthmectomy, black isthmus and right lobe intraoperatively)
Véliz et al.[121]	1 (35)	1F	Graves' disease	Left hemiagenesis
Duh et al.[122]	1 (-)	-	Hyperparathyroidism (hyperplastic parathyroidectomy; glands and nerves in usual positions)	Left hemiagenesis
Letonturier et al.[123]	8 (-)	8F	Simple goiter (n = 4); thyrotoxicosis (n = 2); cold nodule (n = 2)	Left hemiagenesis (n = 6) and Right hemiagenesis (n = 2)
Golden et al.[124]	1 (37 weeks)	-	Malformations (pectus excavatum, hypoplastic right clavicle, dextroscoliosis)	Right hemiagenesis
Ramos et al.[125]	3 (NB)	2F/1M	Congenital hypothyroidism	-
Bando et al.[126]	1 (40)	1F	Hashimoto's thyroiditis with progression to Graves' disease	Right hemiagenesis and absence of isthmus

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Sheridan et al.[127]	1 (29)	1F	Hashimoto's Thyroiditis	Left hemiagenesis and absence of isthmus
Berni et al.[128]	1 (35)	1F	Carcinoma of the thyroglossal duct cyst	Right hemiagenesis
Tonacchera et al.[129]	6 (mean 20.5 years)	-	Euthyroid	Left hemiagenesis (n = 6)
Serdengeçti et al.[130]	1 (8)	1F	Graves' disease with ophthalmopathy	Left hemiagenesis
Alam et al.[131]	1 (45)	1F	Goiter	Right hemiagenesis
Cammareri et al.[132]	1 (-)	1F	Williams syndrome; subclinical hypothyroidism	Left hemiagenesis
Woo et al.[133]	1 (5)	1F	Cervical chondrocutaneous branchial remnant	Right hemiagenesis
Gursoy et al.[134]	1 (19)	1M	Dilated cardiomyopathy and hypergonadotropic hypogonadism (DCM-HH syndrome)	Left hemiagenesis
Piera et al.[135]	3 (40-54)	3F	Adenomatous goiter (n = 3)	Left hemiagenesis (n = 2) and Right hemiagenesis (n = 1)
Supakul et al.[136]	2 (NB)	1F/1M	Congenital hypothyroidism (n = 2); ectopic thyroid (n = 1)	Right hemiagenesis (n = 2)
Hopwood et al.[137]	2[5,34]	2F	Lymphocytic thyroiditis (n = 1); ectopic thyroid (n = 1)	Left hemiagenesis (n = 2)
McLean et al.[138]	1 (NB)	1M	Congenital hypothyroidism	Left hemiagenesis and absence of isthmus
Braga-Basaria et al.[139]	1 (44)	1F	Complex nodule	Left hemiagenesis
De Remigis et al.[140]	2 (18-66)	2F	Euthyroid	Left hemiagenesis (n = 2)
Hashemipour et al.[141]	16 (RN)	5F/11M	Congenital hypothyroidism	-
Passeri et al.[142]	1 (RN)	-	Congenital hypothyroidism	Right hemiagenesis
Beltrão et al.[143]	1 (>3 years)	-	Ectopic thyroid; Congenital hypothyroidism	Left hemiagenesis
Devos et al.[144]	1 (-)	1F	Congenital hypothyroidism	Left hemiagenesis
Retnam et al.[145]	1 (26)	1F	Euthyroid	Left hemiagenesis
Marwaha et al.[146]	1 (-)	1F	Nodular goiter with lymphocytic thyroiditis	Left hemiagenesis
Leckie et al.[147]	2 (-)	2F	Nodular goiter (n = 2)	Left hemiagenesis (n = 2)

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Table 1. Continued...

Study	Number of patients (age or age range)	Sex	Thyroid disease	Anatomical description, surgical or imaging findings
Tonacchera et al.[148]	4	4F	Euthyroid (n = 2); Subclinical hypothyroidism (n = 2)	Left hemiagenesis (n = 4)
Perry et al.[149]	3 (NB)	3F	Congenital hypothyroidism	Left hemiagenesis (n = 1) and Right hemiagenesis (n = 2)
Vaswani et al.[150]	1 (70)	1F	Adenomatous nodules	Left hemiagenesis
Srichomkwun et al.[151]	1 (8)	1F	Congenital hypothyroidism	-
Lazzarin et al.[152]	1 (40)	1F	Hashimoto's Thyroiditis	-
Vakili et al.[153]	1 (14 months)	1F	Congenital hypothyroidism	Left hemiagenesis
Nair et al.[154]	2 (18 and 45 years)	2F	Euthyroid (n = 2)	Left hemiagenesis (n = 1) Right hemiagenesis (n = 1)

Captions: F = female; M = male; NB = newborn; n = number; **-**: information not given.

Results

Case reports

These are two patients: the first, a 58-year-old woman with hypothyroidism undergoing hormonal replacement, and the second, a 48-year-old euthyroid man, both diagnosed with thyroid nodules through routine ultrasonographic examinations. The ultrasonography of both patients, evaluated retrospectively, was suspicious for hemiagenesis of the left thyroid lobe, as shown in Table 2. The investigation with fine-needle aspiration (FNA) biopsy revealed a nodule suspected of malignancy in the woman (Bethesda IV) and consistent with papillary carcinoma (Bethesda VI) in the man. For both cases, total thyroidectomy was indicated as the treatment for this condition.

The thyroidectomy was performed under general anesthesia, with intraoperative monitoring of the vagal and laryngeal nerves and high-frequency bipolar forceps. The resection of the right lobe occurred in the usual manner without complications, including the detachment of the isthmus and the pyramidal lobe, respectively, from the pre-tracheal and pre-laryngeal fasciae. In both procedures, it was decided to keep the entire gland in a single piece. When approaching the left thyroid bed, only a projection of the lateral portion of the isthmus over the trachea was noticed, and the complete absence of the left lobe. There was no contact of the remaining thyroid tissue with the inferior laryngeal nerve or the parathyroids, which were found in their usual positions, as shown in Figure 1. In the female patient's case, there was no evidence of vascularization of the thyroid stump by the left cervical vessels, and in the male patient's case, only the middle thyroid vein crossing the inferior laryngeal nerve was observed.

Table 2. Ultrasound features of two cases of left-lobe THA.

Case	Characteristics of the Nodules	Right lobe	Left lobe	Isthmus	Estimated gland volume
Woman, 58 years old	Nodule 1: predominantly solid, isoechoic, with well-defined contours, without intervening echogenic foci, in the upper/middle third of the right lobe, measuring 3.8 x 2.3 x 1.8 cm, with peripheral and central flow. Nodule 2: mixed, isoechoic, with well-defined contours, without intervening echogenic foci, in the lower third at the transition between the right lobe and the isthmus, measuring 3.7 x 3.8 x 1.7 cm, with peripheral and central flow.	5.8 x 2.2 x 2.2 cm (estimated volume: 14.0 mL).	3.9 x 0.9 x 1.2 cm (estimated volume: 2.1 mL)	4.4 x 2.7 x 1.9 cm (estimated volume: 11.3 mL)	27.4 mL
Man, 48 years old	Solid, hypoechoic, with well-defined contours, without microcalcifications, in the upper third of the right lobe, measuring 1.0 x 1.0 x 0.5 cm, with peripheral and central vascularization.	5.8 x 2.7 x 2.3 cm (estimated volume: 18.4 mL)	2.1 x 1.0 x 0.8 cm (estimated volume: 0.8 mL)	3.0 x 3.0 x 0.4 cm (estimated volume: 2.0 mL)	21.2 mL

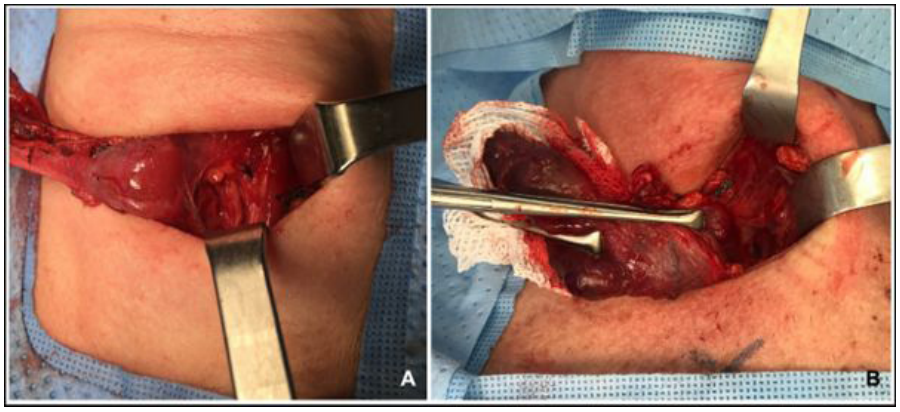

Figure 1. Intraoperative view showing the projection of the lateral portion of the isthmus over the trachea and the complete absence of the left lobe. **A -** 48-year-old man with papillary carcinoma of the right thyroid lobe. **B -** 58-year-old woman with lymphocytic thyroiditis.

A small exploration of the left bed was also conducted, with no signs of detached goiter evident. In the surgical specimen (Figure 2), one can note the vicarious right lobe, the small projection of the isthmus into the left thyroid bed, and the absence of the left lobe in both cases.

The postoperative course for both patients proceeded without complications. Inflammatory nodules due to lymphocytic thyroiditis were confirmed in the woman, and papillary carcinoma in the man, who did not require adjuvant treatment because of the low risk of the tumor and an excellent biochemical response. The patients are in outpatient follow-up, the first for 7 years and the second for 3 years, respectively on appropriate replacement and hormonal suppression.

Results from the systematic review

With the articles included in the review[1-154], 520 patients with descriptions of THA were identified, of whom 50 (9.6%) also coexisted with the absence of the isthmus. Out of the total cases, 363 (74.1%) were women and 127 were men (in 30 cases, the patient's sex was not described). Most of these patients, or 313 cases (75.6%), presented with hemiagenesis of the left lobe, and 101 with hemiagenesis of the right lobe, with the absence of this information in 106 reports. The ages at diagnosis for the condition ranged from newborns to patients as old as 89 years, with a weighted average age of 30 years for the studies that described it.

Although many cases of THA were present in asymptomatic and euthyroid patients (234 cases - 73.1%), having been discovered in incidental findings of examinations or through screening proposed by the study, 34 patients (10.6%) had hyperthyroidism and 52 (16.3%) had hypothyroidism, in the 320 cases where thyroid function was described. Some conditions were more frequently found in patients with THA, such as Graves' disease (27 cases), Hashimoto's thyroiditis (14 cases), thyroid carcinoma (18 cases), ectopic thyroid tissue (9 cases), and congenital hypothyroidism (62 cases). Other rarer conditions, and consequently with a smaller number of associations, were also found in this review, such as Williams Syndrome.

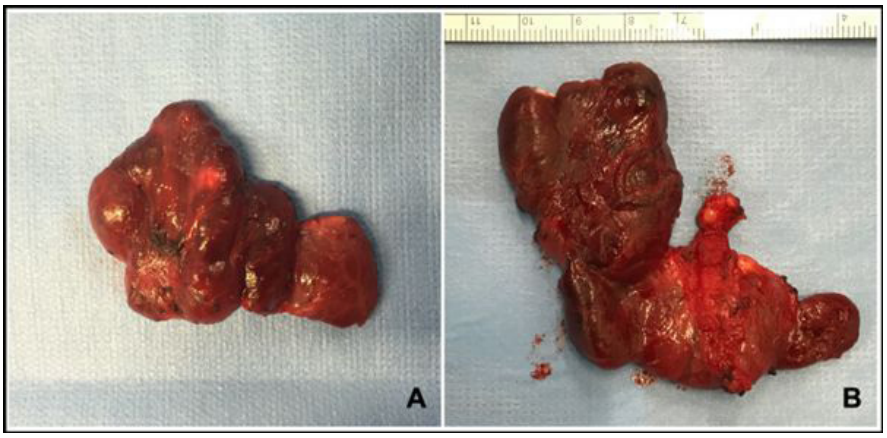

Figure 2. Specimens demonstrating the absence of the left thyroid lobe and compensatory right lobe. **A -** 48-year-old man with papillary carcinoma of the right thyroid lobe; **B -** 58-year-old woman with lymphocytic thyroiditis.

Discussion

This study demonstrates two cases of THA in patients with different glandular diseases. The condition should be suspected, especially in the evaluation of the ultrasound examination with the description of a vicarious thyroid lobe and the contralateral lobe with very reduced dimensions. Although rare, it is essential that head and neck surgeons be aware of this possibility, avoiding unnecessary manipulation of the absent thyroid bed and, consequently, preventing complications.

The current review showed a higher prevalence of left-sided THA and in females, with normal thyroid function being the condition most frequently described. The two cases reported in this study had distinct diseases, as well as completely different demographic and clinical data, showing that the condition should be assessed regardless of these characteristics.

According to the surveyed studies, the prevalence of THA in the general population was estimated between 0.05 and 0.2%[6], but its real prevalence remains uncertain because of the number of asymptomatic and undiagnosed cases. Maiorana et al.[21] conducted a study detecting THA in 24,032 children in Sicily, Italy, using ultrasound, and found a similar prevalence of 0.05% (12 children). Shabana et al.[5] carried out the same type of study in 2,845 children in Belgium, where six cases of THA were detected (0.2%).

The causes of this phenomenon are also uncertain to date. One of the most accepted explanations is that sporadic cases of THA are caused by epigenetic factors, resulting in a failure in the final positioning and development of the thyroid gland[8]. The main genes related to THA are the following thyroid transcription factors: TTF1 (NKX2-1), TTF2 (FOXE1), and PAX8. Their co-expression is exclusively associated with the thyroid gland. They have an action in cellular differentiation, and mutations are linked to thyroid dysgenesis, mainly THA or ectopic thyroid[72].

Some anatomical variations associated with thyroid hemiagenesis have been described. Gandla et al.[34] observed in one patient the absence of ipsilateral superior thyroid vessels to the hemiagenesis, a finding noted intraoperatively. Konno et al.[107] described the absence of left thyroid arteries, ipsilateral to the side of hemiagenesis, visualized in angiography. Folsom et al.[120] reported a case in which black staining of the isthmus was observed intraoperatively as a result of prior use of minocycline. The other studies did not describe other findings of anatomical changes.

Conclusion

Thyroid hemiagenesis (THA) was found to be more prevalent in female, young, and euthyroid patients. However, considering all the reports available in the literature, along with the two from the present study, this condition should be contemplated regardless of the patients' demographic scenarios and associated thyroid diseases. Although rare, it is vital for head and neck surgeons to be aware of this possibility, avoiding unnecessary manipulation of the absent thyroid bed and, consequently, preventing complications.

References

1. Szczepanek-Parulska E, Budny B, Borowczyk M, Zawadzka K, Sztromwasser P, Ruchała M. Compound heterozygous GLI3 variants in siblings with thyroid hemiagenesis. Endocrine. 2021;71(2):514-9. **http://dx.doi.org/10.1007/s12020-020-02422-1**. PMid:32696176.

2. Ruchala M, Szczepanek E, Szaflarski W, Moczko J, Czarnywojtek A, Pietz L, Nowicki M, Niedziela M, Zabel M, Köhrle J, Sowinski J. Increased risk of thyroid pathology in patients with thyroid hemiagenesis: results of a large cohort case-control study. Eur J Endocrinol. 2010;162(1):153-60. **http://dx.doi.org/10.1530/EJE-09-0590**. PMid:19846597.

3. Lesi OK, Thapar A, Appaiah NNB, Iqbal MR, Kumar S, Maharaj D, Saad Abdalla Al-Zawi A, Dindyal S. Thyroid hemiagenesis: narrative review and clinical implications. Cureus. 2022;14(2):e22401. **http://dx.doi.org/10.7759/cureus.22401**. PMid:35371763.

4. Melnick JC, Stemkowski PE. Thyroid hemiagenesis (hockey stick sign): a review of the world literature and a report of four cases. J Clin Endocrinol Metab. 1981;52(2):247-51. **http://dx.doi.org/10.1210/jcem-52-2-247**. PMid:7462390.

5. Shabana W, Delange F, Freson M, Osteaux M, De Schepper J. Prevalence of thyroid hemiagenesis: ultrasound screening in normal children. Eur J Pediatr. 2000;159(6):456-8. **http://dx.doi.org/10.1007/s004310051307**. PMid:10867854.

6. Gursoy A, Anil C, Unal AD, Demirer AN, Tutuncu NB, Erdogan MF. Clinical and epidemiological characteristics of thyroid hemiagenesis: ultrasound screening in patients with thyroid disease and normal population. Endocrine. 2008;33(3):338-41. **http://dx.doi.org/10.1007/s12020-008-9095-5**. PMid:19016002.

7. Velayutham K, Mahadevan S, Velayutham L, Jayapaul M, Appakalai B, Kannan A. A case of hemiagenesis of thyroid with double ectopic thyroid tissue. Indian J Endocrinol Metab. 2013;17(4):756-8. **http://dx.doi.org/10.4103/2230-8210.113777**. PMid:23961502.

8. Campennì A, Giovinazzo S, Curtò L, Giordano E, Trovato M, Ruggeri RM, Baldari S. Thyroid hemiagenesis, Graves' disease and differentiated thyroid cancer: a very rare association: case report and review of literature. Hormones (Athens). 2015;14(3):451-8. **http://dx.doi.org/10.14310/horm.2002.1606**. PMid:26188237.

9. Bhartiya S, Verma A, Basu S, Shukla V. Congenital thyroid hemiagenesis with multinodular goiter. Acta Radiol Short Rep. 2014;3(9):2047981614530286. **http://dx.doi.org/10.1177/2047981614530286**. PMid:25379177.

10. Sasaki H, Futata T, Ninomiya H, Higashi Y, Okumura MCT. CT and MR imagings of single thyroid lobe (thyroid hemiagenesis) with Graves' disease. Postgrad Med J. 1991;67(789):701. **http://dx.doi.org/10.1136/pgmj.67.789.701**. PMid:1924071.

11. Peña S, Robertson H, Walvekar RR. Thyroid hemiagenesis: report of a case and review of literature. Indian J Otolaryngol Head Neck Surg. 2011;63(2):198-200. **http://dx.doi.org/10.1007/s12070-011-0246-2**. PMid:22468261.

12. Shaha AR, Gujarati R. Thyroid hemiagenesis. J Surg Oncol. 1997;65(2):137-40. **http://dx.doi.org/10.1002/(SICI)1096-9098(199706)65:2<137::AID-JSO12>3.0.CO;2-2**. PMid:9209527.

13. Wang M, Hou L, Chen M, Ren L, Tang P, Zhang Y, Jiang J. Thyroid hemiagenesis and Hashimoto's thyroditis-diagnostic and treatment pitfalls. World J Surg Oncol. 2017;15(1):182. **http://dx.doi.org/10.1186/s12957-017-1250-0**. PMid:28985747.

14. Matsumura LK, Russo EM, Dib SA, Maciel RM, Chacra AR. Hemiagenesis of the thyroid gland and T3 hyperthyroidism. Postgrad Med J. 1982;58(678):244-6. **http://dx.doi.org/10.1136/pgmj.58.678.244**. PMid:7111107.

15. Sharma R, Mondal A, Popli M, Sahoo M, Malhotra N, Soni S. Hemiagenesis of the thyroid associated with chronic lymphocytic thyroiditis. Clin Nucl Med. 2001;26(6):506-8. **http://dx.doi.org/10.1097/00003072-200106000-00005**. PMid:11353296.

16. Isreb S, Alem F, Smith D. Left thyroid hemiagenesis in a patient with primary hyperparathyroidism. BMJ Case Rep. 2010;2010(1):bcr0320102864. **http://dx.doi.org/10.1136/bcr.03.2010.2864**. PMid:22767679.

17. Kocakusak A, Akinci M, Arikan S, Sunar H, Yucel AF, Senturk O. Left thyroid lobe hemiagenesis with hyperthyroidism: report of a case. Surg Today. 2004;34(5):437-9. **http://dx.doi.org/10.1007/s00595-003-2726-9**. PMid:15108083.

18. Cansu GB, Taşkıran B, Bahçeci T. Thyroid hemiagenesis associated with Graves' disease: a case report and review of the literature. Acta Endocrinol. 2017;13(3):342-8. **http://dx.doi.org/10.4183/aeb.2017.342**. PMid:31149198.

19. De Sanctis V, Soliman AT, Di Maio S, Elsedfy H, Soliman NA, Elalaily R. Thyroid hemiagenesis from childhood to adulthood: review of literature and personal experience. Pediatr Endocrinol Rev. 2016;13(3):612-9. PMid:27116848.

20. Pizzini AM, Papi G, Corrado S, Carani C, Roti E. Thyroid hemiagenesis and incidentally discovered papillary thyroid cancer: case report and review of the literature. J Endocrinol Invest. 2005;28(3):66-71. **http://dx.doi.org/10.1007/BF03345532**. PMid:15816374.

21. Maiorana R, Carta A, Floriddia G, Leonardi D, Buscema M, Sava L, Calaciura F, Vigneri R. Thyroid hemiagenesis: prevalence in normal children and effect on thyroid function. J Clin Endocrinol Metab. 2003;88(4):1534-6. **http://dx.doi.org/10.1210/jc.2002-021574**. PMid:12679435.

22. Rajmil HO, Rodríguez-Espinosa J, Soldevila J, Ordóñez-Llanos J. Thyroid hemiagenesis in two sisters. J Endocrinol Invest. 1984;7(4):393-4. **http://dx.doi.org/10.1007/BF03351023**. PMid:6438224.

23. Hamburger JI, Hamburger SW. Thyroidal hemiagenesis: report of a case and comments on clinical ramifications. Arch Surg. 1970;100(3):319-20. **http://dx.doi.org/10.1001/archsurg.1970.01340210095026**. PMid:5414524.

24. Çitgez B, Yetkin G, Uludağ M, Akgün İ, Kartal A, Ferhatoğlu F, Kabukçuoğlu F, Akçakaya A. Thyroid hemiagenesis: a case report. Turk J Surg. 2019;35(4):329-31. **http://dx.doi.org/10.5578/turkjsurg.3228**. PMid:32551432.

25. Park IH, Kwon SY, Jung KY, Woo JS. Thyroid hemiagenesis: clinical significance in the patient with thyroid nodule. J Laryngol Otol. 2006;120(7):605-7. **http://dx.doi.org/10.1017/S0022215106001101**. PMid:16834809.

26. Büyükdereli G, Guney IB, Kibar M, Kinaci C. Thyroid hemiagenesis: a report of three cases and review of the literature. Ann Nucl Med. 2005;19(2):147-50. **http://dx.doi.org/10.1007/BF03027394**. PMid:15909495.

27. Chuang KF, Lee JC, Lee CJ. Thyroid hemiagenesis accompanying an ectopic lingual thyroid. Ear Nose Throat J. 2021;1455613211036229. **http://dx.doi.org/10.1177/01455613211036229**. PMid:34525880.

28. Sereke SG, Oriekot A, Bongomin F. Thyroid hemiagenesis with a TI-RADS 2 nodule in the contralateral lobe. Thyroid Res. 2021;14(1):10. **http://dx.doi.org/10.1186/s13044-021-00101-5**. PMid:33931088.

29. Kartini D, Panigoro SS, Ham MF, Harahap AS, Rasyid SH, Marcevianto KV. Thyroid hemiagenesis associated with Hurthle cell carcinoma: a case report. Int J Surg Case Rep. 2021;86:106372. **http://dx.doi.org/10.1016/j.ijscr.2021.106372**. PMid:34507192.

30. Schneider C, Dietlein M, Faust M, Drzezga A, Schmidt M. Thyroid hemiagenesis is combined with a variety of thyroid disorders. Nukl Nucl Med. 2019;58(3):265-71. **http://dx.doi.org/10.1055/a-0830-4425**. PMid:30974469.

31. Mikosch P, Weixlbaumer V, Irrgang M, Aistleitner A, Trifina-Mikosch E. Hemiagenesis of the thyroid gland detected by coincidence-what is the clinical relevance? Case report and review of the literature. Wien Med Wochenschr. 2020;170(15-16):403-9. **http://dx.doi.org/10.1007/s10354-020-00783-w**. PMid:33026543.

32. Wang J, Gao L, Song C. Thyroid hemiagenesis associated with medullary or papillary carcinoma: report of cases. Head Neck. 2014;36(11):E106-11. **http://dx.doi.org/10.1002/hed.23501**. PMid:24115043.

33. Hsieh KC, Patel M, Palacios E, Neitzschman HR. Thyroid hemiagenesis. Ear Nose Throat J. 2012;91(5):190-4. **http://dx.doi.org/10.1177/014556131209100505**. PMid:22614551.

34. Gandla S, Halkud R, Siddappa KT, Murthy SP, Ray SL, Samriddhi, Greeshma P. Thyroid hemiagenesis and papillary carcinoma: a rare association. Indian J Surg Oncol. 2020;11(S1, Suppl. 1):84-6. **http://dx.doi.org/10.1007/s13193-020-01068-9**. PMid:33088136.

35. Peteiro-Gonzalez D, Cabezas-Agricola JM, Casanueva FF. [Thyroid hemiagenesis: report of five cases and literature review]. Endocrinol Nutr. 2013;60(8):e15-7. **http://dx.doi.org/10.1016/j.endonu.2012.09.013**. PMid:23333635.

36. Sari O, Ciftçi I, Törü M, Erbaş B. Thyroid hemiagenesis. Clin Nucl Med. 2000;25(10):766-8. **http://dx.doi.org/10.1097/00003072-200010000-00002**. PMid:11043712.

37. McHenry CR, Walfish PG, Rosen IB, Lawrence AM, Paloyan E. Congenital thyroid hemiagenesis. Am Surg. 1995;61(7):634-8. PMid:7793746.

38. Karabay N, Comlekci A, Canda MS, Bayraktar F, Degirmenci B. Thyroid hemiagenesis with multinodular goiter: a case report and review of the literature. Endocr J. 2003;50(4):409-13. **http://dx.doi.org/10.1507/endocrj.50.409**. PMid:14599114.

39. Ferrari CC, Lorenz K, Dionigi G, Dralle H. Surgical strategy for primary hyperparathyreoidism with thyroid hemiagenesis. Langenbecks Arch Surg. 2014;399(8):1077-81. **http://dx.doi.org/10.1007/s00423-014-1228-0**. PMid:25078534.

40. Jha PS, Rote-Kaginalkar V, Titare P, Jadhav MB. Hemiagenesis of thyroid with dual thyroid ectopia: a rare case report. Indian J Radiol Imaging. 2018;28(1):14-7. **http://dx.doi.org/10.4103/ijri.IJRI_292_17**. PMid:29692520.

41. Suzuki S, Midorikawa S, Matsuzuka T, Fukushima T, Ito Y, Shimura H, Takahashi H, Ohira T, Ohtsuru A, Abe M, Suzuki S, Yamashita S. Prevalence and Characterization of Thyroid Hemiagenesis in Japan: The Fukushima Health Management Survey. Thyroid Off J Am Thyroid Assoc. 2017;27(8):1011-6. **http://dx.doi.org/10.1089/thy.2016.0662**. PMid:28657504.

42. Kada S, Tanaka M, Yasoda A. Parathyroid carcinoma in a patient with secondary hyperparathyroidism and thyroid hemiagenesis: a case report and review of the literature. Ear Nose Throat J. 2021;1455613211036240. **http://dx.doi.org/10.1177/01455613211036240**. PMid:34318689.

43. Oruci M, Ito Y, Buta M, Radisavljevic Z, Pupic G, Djurisic I, Dzodic R. Right thyroid hemiagenesis with adenoma and hyperplasia of parathyroid glands -case report. BMC Endocr Disord. 2012;12(1):29. **http://dx.doi.org/10.1186/1472-6823-12-29**. PMid:23148717.

44. Wu YHE, Wein RO, Carter B. Thyroid hemiagenesis: a case series and review of the literature. Am J Otolaryngol. 2012;33(3):299-302. **http://dx.doi.org/10.1016/j.amjoto.2011.08.007**. PMid:21925764.

45. Gurleyik G, Gurleyik E. Thyroid hemiagenesis associated with hyperthyroidism. Case Rep Otolaryngol. 2015;2015:829712. **http://dx.doi.org/10.1155/2015/829712**. PMid:26185699.

46. Alqahtani SM, Alanesi S, Alalawi Y. Thyroid hemiagenesis with primary hyperparathyroidism or papillary thyroid carcinoma: a report of two cases and literature review. Clin Case Rep. 2021;9(3):1615-20. **http://dx.doi.org/10.1002/ccr3.3856**. PMid:33768901.

47. Yildiz M, Bozkurt MK. Thyroid hemiagenesis. J Adolesc Health. 2003;33(4):291-2. **http://dx.doi.org/10.1016/S1054-139X(03)00132-0**. PMid:14519572.

48. Chun S, Lee YS, Yu J. Thyroid imaging study in children with suspected thyroid dysgenesis. Ann Pediatr Endocrinol Metab. 2021;26(1):53-9. **http://dx.doi.org/10.6065/apem.2040120.060**. PMid:33819958.

49. Kirdak T, Gulcu B, Korun N. Thyroid hemiagenesis associated with retrosternal nodular goiter: a case report. Acta Med Iran. 2014;52(9):725-7. PMid:25325212.

50. Bosco D, Cammarata A, Cannarella R, Latino R, Lanteri R, Di Cataldo A, Calogero A. Thyroid hemiagenesis associated with multinodular goiter and Hashimoto's thyroiditis. G Chir. 2017;38(6):291-4. **http://dx.doi.org/10.11138/gchir/2017.38.6.291**. PMid:29442060.

51. Ayaz ÜY, Ayaz S, Döğen ME, Api A. Ultrasonographic and scintigraphic findings of thyroid hemiagenesis in a child: report of a rare male case. Case Rep Radiol. 2015;2015:917504. **http://dx.doi.org/10.1155/2015/917504**. PMid:25785218.

52. Nsame D, Chadli A, Hallab L, El Aziz S, El Ghomari H, Farouqi A. Thyroid hemiagenesis associated with Hashimoto's thyroiditis. Case Rep Endocrinol. 2013;2013:414506. **http://dx.doi.org/10.1155/2013/414506**. PMid:24198979.

53. Gurleyik E, Dogan S, Cetin F, Gursoy F, Ipor AM. Toxic adenoma in a patient with thyroid hemiagenesis. Cureus. 2017;9(9):e1695. **http://dx.doi.org/10.7759/cureus.1695**. PMid:29159003.

54. Sato H, Tsukahara K, Motohashi R, Wakiya M, Serizawa H, Kurata A. Thyroid carcinoma on the side of the absent lobe in a patient with thyroid hemiagenesis. Case Rep Otolaryngol. 2017;2017:4592783. **http://dx.doi.org/10.1155/2017/4592783**. PMid:29279781.

55. Reya N, Posocco D, Dadparvar S. Thyroid scintigraphy of a rare case of left thyroid lobe hemiagenesis with subacute thyroiditis. Clin Nucl Med. 2022;47(3):e294-5. **http://dx.doi.org/10.1097/RLU.0000000000004017**. PMid:35025799.

56. Aydogan F, Aydogan A, Akkucuk S, Ustun I, Gokce C. Thyroid hemiagenesis, ectopic submandibular thyroid tissue, and apparent persistent subclinical thyrotoxicosis. Thyroid Off J Am Thyroid Assoc. 2013;23(5):633-5. **http://dx.doi.org/10.1089/thy.2012.0079**. PMid:23157170.

57. Verma A, Bhartiya SK, Basu SP, Shukla VK, Shukla RC. Congenital thyroid hemiagenesis with thyroid nodules-Role of TI-RADS to prevent long term thyroid replacement therapy. Int J Surg Case Rep. 2016;27:59-62. **http://dx.doi.org/10.1016/j.ijscr.2016.07.055**. PMid:27544726.

58. Mikosch P, Gallowitsch HJ, Kresnik E, Molnar M, Gomez I, Lind P. Thyroid hemiagenesis in an endemic goiter area diagnosed by ultrasonography: report of sixteen patients. Thyroid. 1999;9(11):1075-84. **http://dx.doi.org/10.1089/thy.1999.9.1075**. PMid:10595455.

59. Korpal-Szczyrska M, Kosiak W, Swieton D. Prevalence of thyroid hemiagenesis in an asymptomatic schoolchildren population. Thyroid. 2008;18(6):637-9. **http://dx.doi.org/10.1089/thy.2007.0408**. PMid:18578613.

60. Ammar FA, Al-Badri MR, Zantout MS, Azar ST. Thyroid hemiagenesis coexisting with brain cavernoma and pituitary Rathke's cleft cyst. J Postgrad Med. 2016;62(2):135-6. PMid:26767975.

61. Baldini M, Orsatti A, Cantalamessa L. A singular case of Graves' disease in congenital thyroid hemiagenesis. Horm Res. 2005;63(3):107-10. PMid:15775712.

62. Kim HJ, Jo HS, Yoo EG, Chung IH, Kim SW, Lee KH, Chang YH. 22q11.2 Microduplication with thyroid hemiagenesis. Horm Res Paediatr. 2013;79(4):243-9. **http://dx.doi.org/10.1159/000346411**. PMid:23364243.

63. Szczepanek-Parulska E, Zybek-Kocik A, Woliński K, Czarnocka B, Ruchała M. Does TSH trigger the anti-thyroid autoimmune processes? Observation on a large cohort of naive patients with thyroid hemiagenesis. Arch Immunol Ther Exp. 2016;64(4):331-8. **http://dx.doi.org/10.1007/s00005-016-0393-y**. PMid:26975391.

64. Wu YHE, Wein RO, Carter B. Thyroid hemiagenesis with multinodular goiter: a case presentation and review of literature. Laryngoscope. 2010;120(Suppl. 4):S191. **http://dx.doi.org/10.1002/lary.21655**. PMid:21225789.

65. Shah RK, Bohara G, Juveria F, Mirza L. Hypothyroidism in thyroid hemiagenesis: a case report. Cureus. 2022;14(3):e23087. **http://dx.doi.org/10.7759/cureus.23087**. PMid:35464580.

66. Berker D, Ozuguz U, Isik S, Aydin Y, Ates Tutuncu Y, Akbaba G, Guler S. A report of ten patients with thyroid hemiagenesis: ultrasound screening in patients with thyroid disease. Swiss Med Wkly. 2010;140(7-8):118-21. **http://dx.doi.org/10.4414/smw.2010.12956**. PMid:20033860.

67. Cakir M, Gonen S, Dikbas O, Ozturk B. Thyroid hemiagenesis with Graves' disease, Graves' ophthalmopathy and multinodular goiter. Intern Med. 2009;48(12):1047-9. **http://dx.doi.org/10.2169/internalmedicine.48.1984**. PMid:19525596.

68. Szczepanek-Parulska E, Budny B, Borowczyk M, Zhukov I, Szutkowski K, Zawadzka K, Tahir R, Minczykowski A, Niedziela M, Ruchała M. NKX2-5 variant in two siblings with thyroid hemiagenesis. Int J Mol Sci. 2022;23(6):3414. **http://dx.doi.org/10.3390/ijms23063414**. PMid:35328834.

69. Yang YS, Hong KH. Case of thyroid hemiagenesis and ectopic lingual thyroid presenting as goitre. J Laryngol Otol. 2008;122(8):e17. **http://dx.doi.org/10.1017/S0022215108003095**. PMid:18577277.

70. Chang J, Gerscovich EO, Dublin AB, McGahan JP. Thyroid hemiagenesis: a rare finding. J Ultrasound Med Off J Am Inst Ultrasound Med. 2011;30(9):1309-10. **http://dx.doi.org/10.7863/jum.2011.30.9.1309**. PMid:21876103.

71. Kroeker TR, Stancoven KM, Preskitt JT. Parathyroid adenoma on the ipsilateral side of thyroid hemiagenesis. Proc Bayl Univ Med Cent. 2011;24(2):92-3. **http://dx.doi.org/10.1080/08998280.2011.11928690**. PMid:21566751.

72. Castanet M, Leenhardt L, Léger J, Simon-Carré A, Lyonnet S, Pelet A, Czernichow P, Polak M. Thyroid hemiagenesis is a rare variant of thyroid dysgenesis with a familial component but without Pax8 mutations in a cohort of 22 cases. Pediatr Res. 2005;57(6):908-13. **http://dx.doi.org/10.1203/01.PDR.0000161409.04177.36**. PMid:15845640.

73. Faulkner J, Varadharajan K, Choudhury N. A UK reported case of Graves' disease with thyroid hemiagenesis. BMJ Case Rep. 2019;12(8):e228094. **http://dx.doi.org/10.1136/bcr-2018-228094**. PMid:31377715.

74. Burman KD, Adler RA, Wartofsky L. Hemiagenesis of the thyroid gland. Am J Med. 1975;58(1):143-6. **http://dx.doi.org/10.1016/0002-9343(75)90546-X**. PMid:1172918.

75. Russotto JA, Boyar RM. Thyroid hemiagenesis. J Nucl Med Off Publ Soc Nucl Med. 1971;12(4):186-7. PMid:5550098.

76. Bough ID Jr, Greco T, Romanczuk B. Thyroid hemiagenesis. Ann Otol Rhinol Laryngol. 1994;103(4 Pt 1):328-30. **http://dx.doi.org/10.1177/000348949410300412**. PMid:8154778.

77. Nakamura S, Isaji M, Ishimori M. Thyroid hemiagenesis with postpartum silent thyroiditis. Intern Med. 2004;43(4):306-9. **http://dx.doi.org/10.2169/internalmedicine.43.306**. PMid:15168773.

78. Prakash R, Narayanan RV, Chakravarty SK. Differentiation between suppressed thyroid tissue and thyroid hemiagenesis with Tc-99m pertechnetate radionuclide angiography. Clin Nucl Med. 1990;15(9):605-9. **http://dx.doi.org/10.1097/00003072-199009000-00003**. PMid:2170071.

79. Greening WP, Sarker SK, Osborne MP. Hemiagenesis of the thyroid gland. Br J Surg. 2005;67(6):446-8. **http://dx.doi.org/10.1002/bjs.1800670621**. PMid:7388347.

80. Sakurai K, Amano S, Enomoto K, Matsuo S, Kitajima A. Primary hyperparathyroidism with thyroid hemiagenesis. Asian J Surg. 2007;30(2):151-3. **http://dx.doi.org/10.1016/S1015-9584(09)60151-2**. PMid:17475589.

81. Tiwari PK, Baxi M, Baxi J, Koirala D. Right-sided hemiagenesis of the thyroid lobe and isthmus: a case report. Indian J Radiol Imaging. 2008;18(4):313-5. **http://dx.doi.org/10.4103/0971-3026.40958**. PMid:19774189.

82. Lee YS, Yun JS, Jeong JJ, Nam KH, Chung WY, Park CS. Thyroid hemiagenesis associated with thyroid adenomatous hyperplasia and papillary thyroid carcinoma. Thyroid. 2008;18(3):381-2. **http://dx.doi.org/10.1089/thy.2007.0281**. PMid:18341383.

83. Philip R, Ashokan A, Philip R, Keshavan C. Graves' disease with thyroid hemiagenesis: a rare abnormality with rarer presentation. Indian J Nucl Med. 2014;29(2):124-5. **http://dx.doi.org/10.4103/0972-3919.130321**. PMid:24761072.

84. Huang SM, Chen HD, Wen TY, Kun MS. Right thyroid hemiagenesis associated with papillary thyroid cancer and an ectopic prelaryngeal thyroid: a case report. J Formos Med Assoc Taiwan Yi Zhi. 2002;101(5):368-71. PMid:12101857.

85. Ozgen AG, Saygili F, Kabalak T. Thyroid hemiagenesis associated with Graves' disease and Graves' ophthalmopathy: case report. Thyroid. 2004;14(1):75-7. **http://dx.doi.org/10.1089/105072504322783885**. PMid:15009918.

86. Nayak DR, Bhandarkar AM, Joy J, Pai K. Neonatal lingual choristoma with thyroid hemiagenesis. BMJ Case Rep. 2015;2015(may06 1):bcr2015209744. **http://dx.doi.org/10.1136/bcr-2015-209744**. PMid:25948857.

87. Shechner C, Kraiem Z, Zuckerman E, Dickstein G. Toxic Graves' disease with thyroid hemiagenesis: diagnosis using thyroid-stimulating immunoglobulin measurements. Thyroid. 1992;2(2):133-5. **http://dx.doi.org/10.1089/thy.1992.2.133**. PMid:1356055.

88. Meringolo D, Campi I, Costante G. Severe Graves' Orbitopathy occurring in a patient with thyroid hemiagenesis. Endocrine. 2018;62(2):490-1. **http://dx.doi.org/10.1007/s12020-018-1662-9**. PMid:29987702.

89. Liu X, Zhang J, Meng Z, Yu H, Gao Z, Li H, Liu N. A case report of 131I therapy for Graves' disease patient with hemiagenesis. Medicine. 2019;98(8):e14606. **http://dx.doi.org/10.1097/MD.0000000000014606**. PMid:30813185.

90. Aslaner A, Aydin M, Ozdere A. Multinodular goitre with thyroid hemiagenesis: a case report and review of the literature. Acta Chir Belg. 2005;105(5):528-30. **http://dx.doi.org/10.1080/00015458.2005.11679774**. PMid:16315840.

91. Mydlarz WK, Zhang K, Micchelli ST, Kim M, Tufano RP. Ipsilateral double parathyroid adenoma and thyroid hemiagenesis. ORL J Otorhinolaryngol Relat Spec. 2010;72(5):272-4. **http://dx.doi.org/10.1159/000312707**. PMid:20733341.

92. Ng TT, Soon DSC, Mahanta V. A tale of two anomalies: fourth branchial cleft cyst with thyroid hemiagenesis. ANZ J Surg. 2018;88(9):E677-8. **http://dx.doi.org/10.1111/ans.13637**. PMid:27193804.

93. Hervás Benito I, Vera Espallardo F, Rivas Sánchez A, López Aznar D, Saura Quiles A, Muñoz M, Bello Arques P, Mateo Navarro A. Association of thyroid hemiagenesis and Graves disease. Rev Esp Med Nucl. 2001;20(2):116-9. PMid:11333821.

94. Papi G, Salvatori R, Ferretti G, Roti E. Thyroid hemiagenesis and autoimmune polyglandular syndrome type III. J Endocrinol Invest. 2003;26(11):1160-1. **http://dx.doi.org/10.1007/BF03345267**. PMid:15008258.

95. Stagi S, Bindi G, Neri AS, Lapi E, Losi S, Jenuso R, Salti R, Chiarelli F. Thyroid function and morphology in patients affected by Williams syndrome. Clin Endocrinol. 2005;63(4):456-60. **http://dx.doi.org/10.1111/j.1365-2265.2005.02365.x**. PMid:16181239.

96. Nebesio TD, Eugster EA. Unusual thyroid constellation in Down syndrome: congenital hypothyroidism, Graves' disease, and hemiagenesis in the same child. J Pediatr Endocrinol Metab. 2009;22(3):263-8. **http://dx.doi.org/10.1515/JPEM.2009.22.3.263**. PMid:19492583.

97. Borges MF, Sedassari NA, Sedassari AA, Souza LRMF, Ferreira BP, Lara BHJ, Palhares HMC. Timing of thyroid ultrasonography in the etiological investigation of congenital hypothyroidism. Arch Endocrinol Metab. 2017;61(5):432-7. **http://dx.doi.org/10.1590/2359-3997000000239**. PMid:28225993.

98. Lee IT, Sheu WHH, Lin SY. Familial form of thyroid dysgenesis: report of thyroid hemiagenesis with accompanying Graves' disease in a woman whose daughter has thyroid agenesis. Horm Res. 2003;59(1):47-9. PMid:12566736.

99. Eroglu M, Ozkul F, Barutcu EC, Arik K, Adam G, Bilen Y, Ukinc K, Asik M. Severe hyperparathyroidism in patient with right thyroid hemiagenesis. J Pak Med Assoc. 2015;65(9):1022-3. PMid:26338756.

100. Karatağ GY, Albayrak ZK, Önay HK, Karatağ O, Peker Ö. Coexistence of thyroid hemiagenesis, nodular goitre and papillary carcinoma. Kulak Burun Bogaz Ihtis Derg. 2013;23(2):115-8. **http://dx.doi.org/10.5606/kbbihtisas.2013.60590**. PMid:23611326.

101. Léger J, Marinovic D, Garel C, Bonaïti-Pellié C, Polak M, Czernichow P. Thyroid developmental anomalies in first degree relatives of children with congenital hypothyroidism. J Clin Endocrinol Metab. 2002;87(2):575-80. **http://dx.doi.org/10.1210/jcem.87.2.8268**. PMid:11836288.

102. Abbassi V, Auth R. Hemiagenesis of the thyroid: clinical and radiological presentation in the pediatric patient. J Nucl Med Off Publ Soc Nucl Med. 1983;24(10):972-3. PMid:6619967.

103. Woods RH, Loury M. Thyroid hemiagenesis in a patient with a parathyroid adenoma. Otolaryngol Head Neck Surg. 1992;107(3):469-71. **http://dx.doi.org/10.1177/019459989210700324**. PMid:1408238.

104. Khatri VP, Espinosa MH, Harada WA. Papillary adenocarcinoma in thyroid hemiagenesis. Head Neck. 1992;14(4):312-5. **http://dx.doi.org/10.1002/hed.2880140411**. PMid:1517082.

105. Hsu CY, Wang SJ. Thyroid hemiagenesis accompanying an ectopic sublingual thyroid. Clin Nucl Med. 1994;19(6):546. **http://dx.doi.org/10.1097/00003072-199406000-00019**. PMid:8062479.

106. Friedman A, Bauman A. Hemiagenesis of the thyroid. South Med J. 1979;72(8):927-9, 932. **http://dx.doi.org/10.1097/00007611-197908000-00008**. PMid:472814.

107. Konno N, Kanaya A. Thyroid hemiagenesis associated with the right aortic arch. J Endocrinol Invest. 1988;11(9):685-7. **http://dx.doi.org/10.1007/BF03350216**. PMid:3221043.

108. Zangeneh F, Miller JL, Intenzo CM. Thyroid gland hemiagenesis with Graves' disease. Thyroid. 2001;11(6):603. **http://dx.doi.org/10.1089/105072501750302930**. PMid:11442010.

109. Kirmızibekmez H, Güven A, Yildiz M, Cebeci AN, Dursun F. Developmental defects of the thyroid gland: relationship with advanced maternal age. J Clin Res Pediatr Endocrinol. 2012;4(2):72-5. **http://dx.doi.org/10.4274/Jcrpe.560**. PMid:22672863.

110. Jain A, Pathak S. Rare developmental abnormalities of thyroid gland, especially multiple ectopia: a review and our experience. Indian J Nucl Med. 2010;25(4):143-6. **http://dx.doi.org/10.4103/0972-3919.78248**. PMid:21713222.

111. Golinger RC. Thyroid hemiagenesis with goiter. JAMA. 1973;224(1):128. **http://dx.doi.org/10.1001/jama.1973.03220140096022**. PMid:4739479.

112. Cerqueira TLO, Ramos YR, Strappa GB, Jesus MS, Santos JG, Sousa C, Carvalho G, Fernandes V, Boa-Sorte N, Amorim T, Silva TM, Ladeia AMT, Acosta AX, Ramos HE. Mutation screening in the genes PAX-8, NKX2-5, TSH-R, HES-1 in cohort of 63 Brazilian children with thyroid dysgenesis. Arch Endocrinol Metab. 2018;62(4):466-71. **http://dx.doi.org/10.20945/2359-3997000000065**. PMid:30304112.

113. Kebapçilar L, Akinci B, Demir T, Bayraktar F, Yeşil S. Hypercalcemia due to Graves' disease in a patient with thyroid hemiagenesis. Kulak Burun Bogaz Ihtis Derg KBB J Ear Nose Throat. 2009;19(3):159-62. PMid:19857196.

114. Rosenberg T, Gilboa Y. Familial thyroid ectopy and hemiagenesis. Arch Dis Child. 1980;55(8):639-41. **http://dx.doi.org/10.1136/adc.55.8.639**. PMid:7436522.

115. Hsu CY, Kao CH, Lin WY, Liao SQ, Wan SJ. The application of Tc-99m thyroid scintigraphy in congenital hypothyroidism. Gaoxiong Yi Xue Ke Xue Za Zhi. 1993;9(5):290-5. PMid:8393495.

116. Duarte GC, Tomimori EK, de Camargo RYA, Catarino RM, Ferreira JE, Knobel M, Medeiros-Neto G. Excessive iodine intake and ultrasonographic thyroid abnormalities in schoolchildren. J Pediatr Endocrinol Metab. 2009;22(4):327-34. **http://dx.doi.org/10.1515/JPEM.2009.22.4.327**. PMid:19554806.

117. Shibutani Y, Inoue D, Koshiyama H, Mori T. Thyroid hemiagenesis with subacute thyroiditis. Thyroid. 1995;5(2):133-5. **http://dx.doi.org/10.1089/thy.1995.5.133**. PMid:7647573.

118. Saydam L, Uğur MB, Bozkurt MK, Ozçelik T. Thyroid hemiagenesis: a case report. Kulak Burun Bogaz Ihtis Derg KBB J Ear Nose Throat. 2003;10(2):69-71. PMid:12717055.

119. Ruchała M, Szczepanek E, Skiba A, Czepczyński R, Sowiński J. Graves' hyperthyroidism following primary hypothyroidism due to Hashimoto's thyroiditis in a case of thyroid hemiagenesis: case report. Neuroendocrinol Lett. 2008;29(1):55-8. PMid:18283259.

120. Folsom DL, Gauderer MW, Dahms WT. Nodular hyperplasia, black thyroid, and chronic minocycline ingestion in a teenager. Arch Surg. 1992;127(12):1476-7. **http://dx.doi.org/10.1001/archsurg.1992.01420120110018**. PMid:1365695.

121. Véliz J, Pineda G. Thyroid hemiagenesis associated with Basedow-Graves disease. Report of a case. Rev Med Chil. 2000;128(8):896-8. PMid:11129551.

122. Duh QY, Ciulla TA, Clark OH. Primary parathyroid hyperplasia associated with thyroid hemiagenesis and agenesis of the isthmus. Surgery. 1994;115(2):257-63. PMid:8310416.

123. Letonturier P, Hazard J, Tourneur R, Perlemuter L, Angel R. Thyroid hemiagenesis (single thyroid lobe). 8 cases (author's transl). Nouv Presse Med. 1979;8(15):1227-9. PMid:440944.

124. Golden ET, Alazraki A, Loewen J, Braithwaite K. Complete sternal cleft associated with right clavicular, manubrial, and thyroid hypoplasia, pectus deformity, and spinal anomalies. Clin Imaging. 2016;40(1):174-6. **http://dx.doi.org/10.1016/j.clinimag.2015.08.003**. PMid:26456118.

125. Ramos HE, Nesi-França S, Boldarine VT, Pereira RM, Chiamolera MI, Camacho CP, Graf H, de Lacerda L, Carvalho GA, Maciel RM. Clinical and molecular analysis of thyroid hypoplasia: a population-based approach in southern Brazil. Thyroid Off J Am Thyroid Assoc. 2009;19(1):61-8. **http://dx.doi.org/10.1089/thy.2008.0116**. PMid:18976153.

126. Bando Y, Nagai Y, Ushiogi Y, Toya D, Tanaka N, Fujisawa M. Development of Graves' hyperthyroidism from primary hypothyroidism in a case of thyroid hemiagenesis. Thyroid. 1999;9(2):183-7. **http://dx.doi.org/10.1089/thy.1999.9.183**. PMid:10090320.

127. Sheridan MF, Bruns AD, Burgess LP. Hemiagenesis of the thyroid gland. Otolaryngol Head Neck Surg. 1995;112(4):621-3.

128. Berni Canani F, Dall'Olio D, Chiarini V, Casadei GP, Papini E. Papillary carcinoma of a thyroglossal duct cyst in a patient with thyroid hemiagenesis: effectiveness of conservative surgical treatment. Endocr Pract Off J Am Coll Endocrinol Am Assoc Clin Endocrinol. 2008;14(4):465-9. **http://dx.doi.org/10.4158/EP.14.4.465**. PMid:18558601.

129. Tonacchera M, Banco ME, Montanelli L, Di Cosmo C, Agretti P, De Marco G, Ferrarini E, Ordookhani A, Perri A, Chiovato L, Santini F, Vitti P, Pinchera A. Genetic analysis of the PAX8 gene in children with congenital hypothyroidism and dysgenetic or eutopic thyroid glands: identification of a novel sequence variant. Clin Endocrinol. 2007;67(1):34-40. **http://dx.doi.org/10.1111/j.1365-2265.2007.02831.x**. PMid:17437516.

130. Serdengeçti M, Ayan A, Sari O. Thyroid hemiagenesis and Graves' disease in a child. Clin Nucl Med. 2009;34(12):884-5. **http://dx.doi.org/10.1097/RLU.0b013e3181bed120**. PMid:20139822.

131. Alam MK. Thyroid hemiagenesis: case report and review of the literature. Ann Saudi Med. 1997;17(6):632-3. **http://dx.doi.org/10.5144/0256-4947.1997.632**. PMid:17338012.

132. Cammareri V, Vignati G, Nocera G, Beck-Peccoz P, Persani L. Thyroid hemiagenesis and elevated thyrotropin levels in a child with Williams syndrome. Am J Med Genet. 1999;85(5):491-4. **http://dx.doi.org/10.1002/(SICI)1096-8628(19990827)85:5<491::AID-AJMG11>3.0.CO;2-Z**. PMid:10405448.

133. Woo HY, Kim HS. Clinicopathological characteristics of cervical chondrocutaneous branchial remnant: a single-institutional experience. Int J Clin Exp Pathol. 2017;10(9):9866-77. PMid:31966875.

134. Gursoy A, Sahin M, Ertugrul DT, Berberoglu Z, Sezgin A, Tutuncu NB, Demirag NG. Familial dilated cardiomyopathy hypergonadotrophic hypogonadism associated with thyroid hemiagenesis. Am J Med Genet A. 2006;140A(8):895-6. **http://dx.doi.org/10.1002/ajmg.a.31161**. PMid:16523513.

135. Piera J, Garriga J, Calabuig R, Bargallo D. Thyroidal hemiagenesis. Am J Surg. 1986;151(3):419-21. **http://dx.doi.org/10.1016/0002-9610(86)90482-4**. PMid:3953964.

136. Supakul N, Delaney LR, Siddiqui AR, Jennings SG, Eugster EA, Karmazyn B. Ultrasound for primary imaging of congenital hypothyroidism. AJR Am J Roentgenol. 2012;199(3):W360-6. **http://dx.doi.org/10.2214/AJR.11.7905**. PMid:22915427.

137. Hopwood NJ, Carroll RG, Kenny FM, Foley TP Jr. Functioning thyroid masses in childhood and adolescence. Clinical, surgical, and pathologic correlations. J Pediatr. 1976;89(5):710-8. **http://dx.doi.org/10.1016/S0022-3476(76)80788-3**. PMid:978316.

138. McLean R, Howard N, Murray IP. Thyroid dysgenesis in monozygotic twins: variants identified by scintigraphy. Eur J Nucl Med. 1985;10(7-8):346-8. **http://dx.doi.org/10.1007/BF00251309**. PMid:4040018.

139. Braga-Basaria M, Basaria S, Mesa C Jr, Stolf AR, Graf H. Sonographically guided percutaneous ethanol treatment of a symptomatic complex nodule with a large cystic component in a patient with thyroid hemiagenesis. J Clin Ultrasound. 2002;30(7):445-9. **http://dx.doi.org/10.1002/jcu.10088**. PMid:12210465.

140. De Remigis P, D'Angelo M, Bonaduce S, Di Giandomenico V, Sensi S. Comparison of ultrasonic scanning and scintiscanning in the evaluation of thyroid hemiagenesis. J Clin Ultrasound. 1985;13(8):561-3. **http://dx.doi.org/10.1002/1097-0096(199010)13:8<561::AID-JCU1870130808>3.0.CO;2-X**. PMid:3934219.

141. Hashemipour M, Ghasemi M, Hovsepian S, Heiydari K, Sajadi A, Hadian R, Mansourian M, Mirshahzadeh N, Kelishadi R, Dalvi M. Etiology of congenital hypothyroidism in Isfahan: does it different? Adv Biomed Res. 2014;3(1):21. **http://dx.doi.org/10.4103/2277-9175.124658**. PMid:24600601.

142. Passeri E, Frigerio M, De Filippis T, Valaperta R, Capelli P, Costa E, Fugazzola L, Marelli F, Porazzi P, Arcidiacono C, Carminati M, Ambrosi B, Persani L, Corbetta S. Increased risk for non-autoimmune hypothyroidism in young patients with congenital heart defects. J Clin Endocrinol Metab. 2011;96(7):E1115-9. **http://dx.doi.org/10.1210/jc.2011-0057**. PMid:21525159.

143. Beltrão CB, Juliano AG, Chammas MC, Watanabe T, Sapienza MT, Marui S. Etiology of congenital hypothyroidism using thyroglobulin and ultrasound combination. Endocr J. 2010;57(7):587-93. **http://dx.doi.org/10.1507/endocrj.K10E-009**. PMid:20467163.

144. Devos H, Rodd C, Gagné N, Laframboise R, van Vliet G. A search for the possible molecular mechanisms of thyroid dysgenesis: sex ratios and associated malformations. J Clin Endocrinol Metab. 1999;84(7):2502-6. **http://dx.doi.org/10.1210/jcem.84.7.5831**. PMid:10404827.

145. Retnam VJ, Nayak UN, Vernekar KS, Bhandarkar SD. Hemi-agenesis of thyroid. J Postgrad Med. 1981;27(1):48-50. PMid:7230077.

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146. Marwaha RK, Khanna CM, Gupta RK, Sharma R. Hemiagenesis associated with chronic lymphocytic thyroiditis. J Assoc Physicians India. 1990;38(7):507-8. PMid:2292562.

147. Leckie RG, Delaplain CB, Watabe JT, Darrow M. Thyroid hemiagenesis by I-123 thyroid scan with high-resolution real-time ultrasound confirmation. Clin Nucl Med. 1993;18(2):161-3. **http://dx.doi.org/10.1097/00003072-199302000-00021**. PMid:8432068.

148. Tonacchera M, Banco M, Lapi P, Di Cosmo C, Perri A, Montanelli L, Moschini L, Gatti G, Gandini D, Massei A, Agretti P, De Marco G, Vitti P, Chiovato L, Pinchera A. Genetic analysis of TTF-2 gene in children with congenital hypothyroidism and cleft palate, congenital hypothyroidism, or isolated cleft palate. Thyroid. 2004;14(8):584-8. **http://dx.doi.org/10.1089/1050725041692864**. PMid:15320969.

149. Perry RJ, Maroo S, Maclennan AC, Jones JH, Donaldson MDC. Combined ultrasound and isotope scanning is more informative in the diagnosis of congenital hypothyroidism than single scanning. Arch Dis Child. 2006;91(12):972-6. **http://dx.doi.org/10.1136/adc.2006.096776**. PMid:16864597.

150. Vaswani K, Vitellas KM, Bennett WF. Case 1. Thyroid hemiagenesis with adenoma. AJR Am J Roentgenol. 2000;175(3):895-8. **http://dx.doi.org/10.2214/ajr.175.3.1750895**. PMid:10954499.

151. Srichomkwun P, Admoni O, Refetoff S, de Vries L. a novel mutation (S54C) of the PAX8 gene in a family with congenital hypothyroidism and a high proportion of affected individuals. Horm Res Paediatr. 2016;86(2):137-42. **http://dx.doi.org/10.1159/000445891**. PMid:27207603.

152. Lazzarin M, Benati F, Menini C. Agenesis of the thyroid lobe associated with Hashimoto's thyroiditis. Minerva Endocrinol. 1997;22(3):75-7. PMid:9557474.

153. Vakili R, Mazlouman SJ. Dyshormonogenic hypothyroidism with normal neurological development, unexplained short stature and facial anomalies in three siblings. Clin Dysmorphol. 2003;12(1):21-7. **http://dx.doi.org/10.1097/00019605-200301000-00004**. PMid:12514361.

154. Nair N. Thyroidal hemiagenesis: a report of two cases. Int J Nucl Med Biol. 1979;6(3):175-6. **http://dx.doi.org/10.1016/0047-0740(79)90034-2**. PMid:521223.