

Parathyroid cysts

A review of 359 patients reported in the international literature

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Abstract

Background: Parathyroid cysts are lesions that represent 1–5% of neck masses. They are subdivided into two categories: functioning and non-functioning.

The aim of the present review is to give a detailed account of all reported cases of parathyroid cysts in the literature and to analyze statistically the available data.

Methods: A bibliographic research was performed from 1905 until 2016. A database with the patients' characteristics was made and analyzed statistically.

Results: A total of 218 articles were found, reporting 359 cases of cysts. Mean age of patients was 49.24 y/o and the male/female ratio was 1:1.85. The most common locations were left thyroid lobe (113/358 patients, 31.6%), and superior mediastinum (69/358 patients, 19.3%), while the most common symptoms were neck mass (148/355 patients, 41.7%), compressive symptoms (73/355 patients, 20.6%) and hyperparathyroidism (62/355 patients, 17.5%). Non-functioning cysts were more frequent (220/357 patients, 61.6%). Regarding dimensions, mean diameter was 4.88 cm. Ultrasound and FNA are used for their diagnosis, while cystic fluid analysis may help the differential diagnosis. Recurrences were mentioned in 27/97 patients (27.8%) with available data. No deaths due to parathyroid cysts were mentioned in the literature.

Conclusion: Parathyroid cysts should be taken into consideration in case of parathyroid dysfunction or asymptomatic neck mass. The surgeon's careful manipulations on the cyst are crucial for a definitive treatment.

Abbreviations: AE1/2 = cytokeratin, CAM 5.3 = cell adhesion molecule 5.3, CT = computed tomography, FNA = fine needle aspiration, LCA = leukocyte common antigen, MRI = magnetic resonance imaging, PC = parathyroid cyst, PTH = parathormone, SMA = smooth muscle actin.

Keywords: parathyroid cyst, parathyroid glands

1. Introduction

Parathyroid cysts (PCs) are relatively rare lesions, which represent less than 0.5% of parathyroid glands' pathologies and account for 1% to 5% of neck masses.^[1–6] The first description of a PC was made by Sandström in 1880,^[7] whereas the first report of surgical excision of a PC was made by Goris in 1905.^[8] PCs can be subdivided into 2 main categories, depending on their hormonal activity: functioning and nonfunctioning ones. In the majority of cases, they are asymptomatic and are incidentally found, although there are also reports of clinically

symptomatic lesions. Common sites that PCs are detected are the anterior neck and the mediastinum.

The aim of the present systematic review is to give a detailed account of all reported cases of PC in the literature and to analyze the available data, in order to completely characterize the entity from epidemiological, medical, and surgical aspects.

2. Methods

A bibliographic research was performed using PubMed, Scopus, Embase, Cochrane Library, and CINAHL. The search term employed was “parathyroid cyst.” In total, 356 articles were found, from which cystic adenomas were excluded. Since 1905, when the first description of PC was made, until 2016, 269 articles were found, from which 51 articles were not included, as 23 of them were published before 1970 and they were not available even in the journal that had been published and the rest 28 articles were impossible to find (after detailed research in medical databases, emails to the correspondence author, cross-references by other available articles) (Fig. 1). As result, 218 articles were included in our database. Among these, we spotted 359 well-documented cases of PC. One-hundred sixty-three articles were English, 24 were Japanese, 11 were French, 9 were Spanish, 2 were German, 4 were Italian, 2 were Portuguese, 1 was Finnish, and 1 was Czech and 1 was Icelandic. These articles were carefully studied and a database with the patients' characteristics was made. The database included gender, age, location of the PC, symptoms, clinical presentation, dimensions of the cyst,

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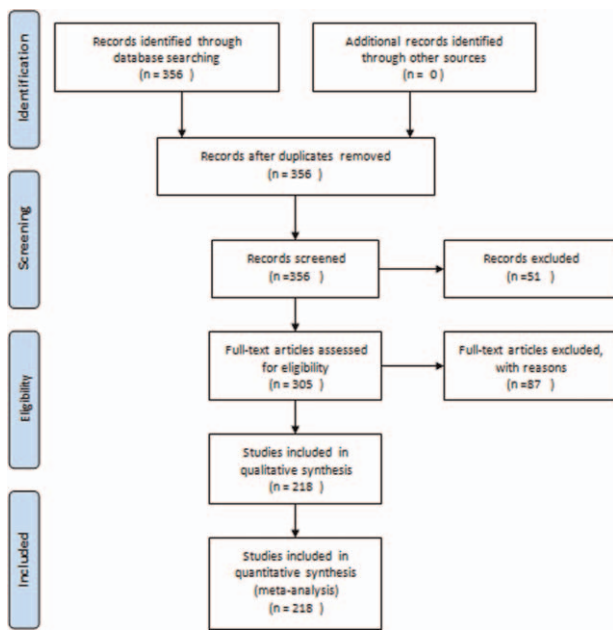


Figure 1. Flow diagram according to PRISMA Statement 2009.

diagnostic methods, histopathological findings of the cyst and the containing fluid, treatment, duration of hospitalization, and follow-up. The cases that fulfilled at least 8 of these 10 criteria have been included in the statistical analysis. Table 1 displays the number of cases presenting the criteria. An ethical approval is not required because this study is a review of the existing international literature.

In order to express results, descriptive statistics were used appropriately. Means, medians, and standard deviations were used for continuous variables.^[9] The normal distribution of quantitative data has been checked using Kolmogorov–Smirnov test. Nonparametric tests (Mann–Whitney *U* test) have been applied for the non-normal distribution data. Spearman rho test has been applied for the correlation between continuous variables. Kruskal–Wallis test and Chi-square test have been applied for the data correlated. Excel 2007 (Microsoft Office Excel 2007, Jones, Chicago) and SPSS 22.0 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) were employed to statistically analyze the data.

Table 1
Cases of parathyroid cysts fulfilling criteria.

Criteria	Number of cases [%] (n = 359)
Age	351 [97.8]
Sex	351 [97.8]
Symptoms	355 [98.9]
Location	358 [99.7]
Clinical presentation	357 [99.4]
Dimensions	267 [74.3]
Diagnostic methods	357 [99.4]
Histopathology and immunohistochemistry	199 [55.43]
Cystic fluid	220 [61.28]
Treatment	333 [92.75]
Postoperative values	348 [96.9]
Hospitalization	30 [8.35]
Follow-up	97 [27]
Recurrence	98 [27.2]

3. Results

Characteristics of PCs were determined concerning gender, age, localization of the PC, symptoms, clinical presentation, dimensions, diagnostic methods, histopathological findings and the containing fluid, treatment, duration of hospitalization, and follow up.

3.1. Gender

Concerning gender, 35% of the patients were male (123 patients), while 65% were female (228 patients). The ratio between men and women was 1:1.85, suggesting a female predominance in the reported PC population.

3.2. Age

Mean age of the population was 49.24 years, ranging from 8 to 88 years. It is concluded that PCs most frequently appeared in age ranges from 30 to 60 years.

We correlated the age distribution among male and female population and we found that there is no statistically significant difference between men and women. (Male Mean Rank: 187.14, Female Mean Rank: 169.27, $U = 12,487.5$, $P = .115$).

3.3. Clinical manifestations

Furthermore, PCs can present with a wide variety of symptoms, ranging from asymptomatic neck masses to the different clinical manifestations of hyperparathyroidism. Our statistical analysis has shown that the most frequent symptom is neck mass (148/355 patients, 41.7%), while PCs presented as thyroid nodule in 25 of 355 patients (7%). Ten patients had a medical history of nephrolithiasis (2.8%), while 6 of 355 patients had thyroid dysfunction in general (1.7%). Parathyroid dysfunction was presented in 62 of 355 patients (17.5%), compressive symptoms in 73 of 355 patients (20.6%), and asthenia, weight loss, fatigue, and depression in 15 of 355 patients (4.2%). Another clinical presentation of PCs was neck pain in 6 of 355 patients (1.7%), while 8 of 355 patients (2.3%) were admitted to an emergency department with mental confusion and deterioration due to undiagnosed hyperparathyroidism. Last but not least, obesity was the main symptom in 2 of 355 patients (0.6%). Figure 2 summarizes all the above symptoms.

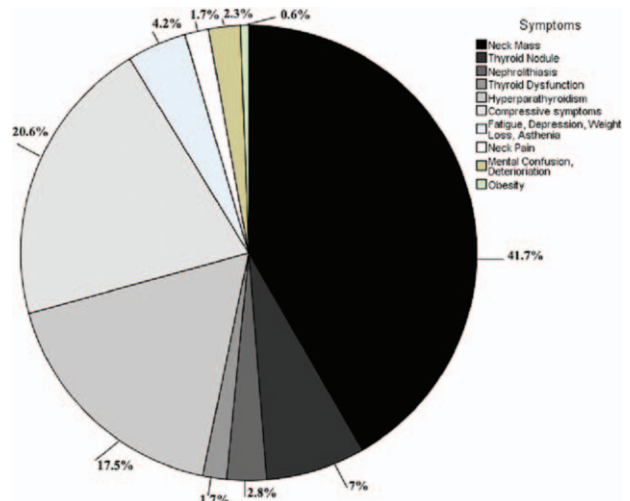


Figure 2. Frequencies of symptoms' categories.

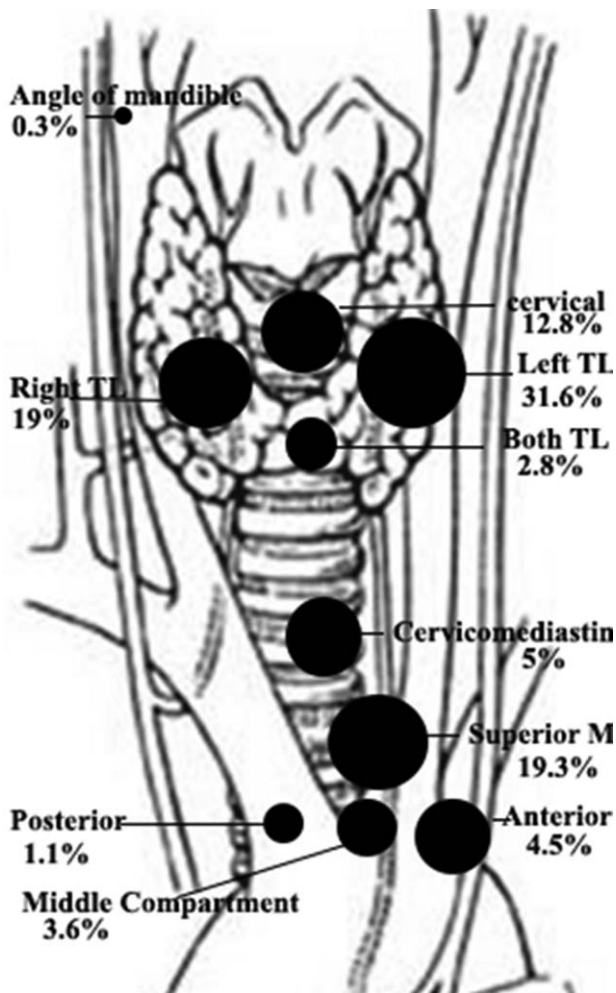


Figure 3. Schematic localization of most frequent sites of parathyroid cysts. The diameter of the dot is proportional to the frequency of appearance.

3.4. Localization

As far as the localization of the PCs is concerned, they can be found from the angle of the mandible until the mediastinum, as shown in Fig. 3. In our population, the most common site was the left thyroid lobe (113/358 patients, 31.6%), while superior mediastinum was the second one (69/358 patients, 19.3%). PC appeared in the right thyroid lobe in 68 of 358 patients (19%) and a cervical localization was found in 46 of 358 patients (12.8%). Cervicomediastinal PCs were found in 18 of 358 patients (5%), while in 16 of 358 patients (4.5%) PC was located in the anterior mediastinum. PCs were found in the middle compartment of mediastinum in 13 of 358 patients (3.6%) and in both thyroid lobes in 10 of 358 patients (2.8%). Posterior mediastinum (4/358 patients, 1.1%) and the angle of the mandible (1/358 patients, 0.3%) represent rarer locations of PCs.

The correlation between age and location using Kruskal-Wallis test showed that there is a different distribution of age among several location of PCs, with anterior and posterior mediastinum coming first, then the thyroid lobes and last the angle of the mandible, as shown in Fig. 4 ($P < .001$).

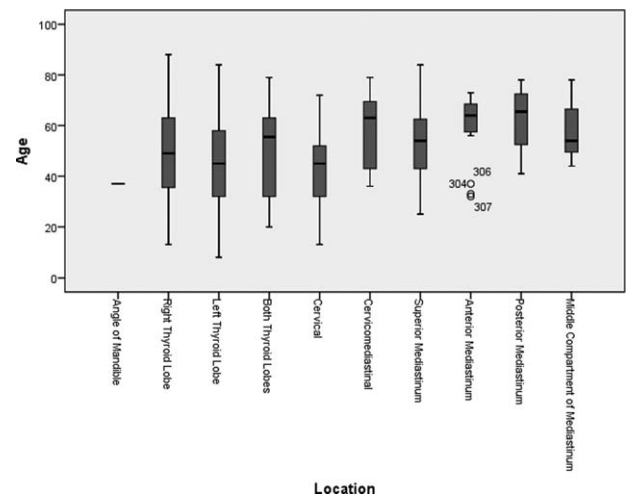


Figure 4. Box-plot demonstrating age distribution among different locations of parathyroid cysts. ($P < .001$).

3.5. Clinical presentation

Furthermore, there are 2 main categories of PCs: the functioning and the nonfunctioning ones. Nonfunctioning PCs were found to be more frequent, as they represent 61.6% of the total amount of patients (220/357 patients).

The correlation between clinical presentation of PCs and gender has shown that there is statistically significant difference between male and female, as nonfunctioning PCs have a female predilection (nonfunctioning: Male=26.5%, Female=73.5%, $P < .001$). The percentages for the functioning PCs were Male=48.5% and Female=51.5% ($P < .001$), suggesting a slight predominance for female population. These results are presented in Fig. 5.

We also correlated age between categories of clinical presentation and came to the conclusion that there was a difference between functioning and nonfunctioning cysts, suggesting a predominance of functioning ones in older patients ($U=8002$, $P < .001$). Figure 6 demonstrates these results.

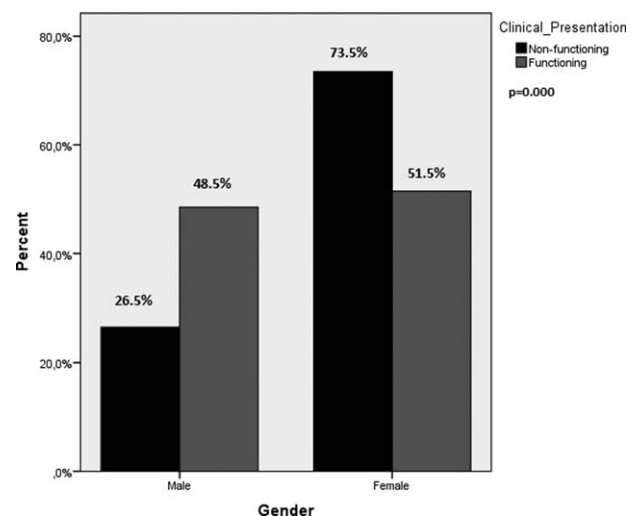


Figure 5. Correlation between gender and clinical presentation. ($P < .001$).

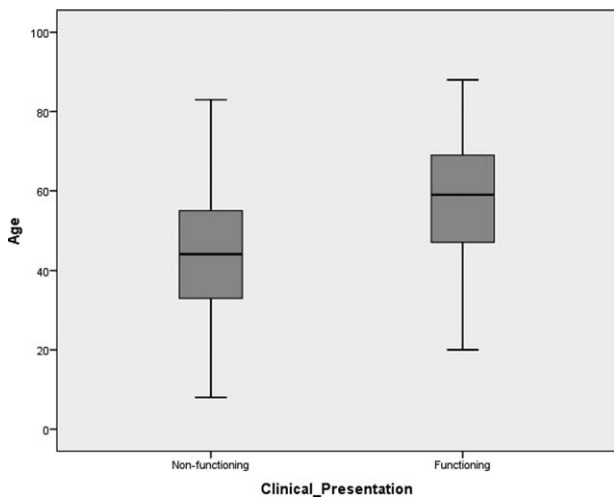


Figure 6. Age distribution among different categories of clinical presentation. ($P < .001$).

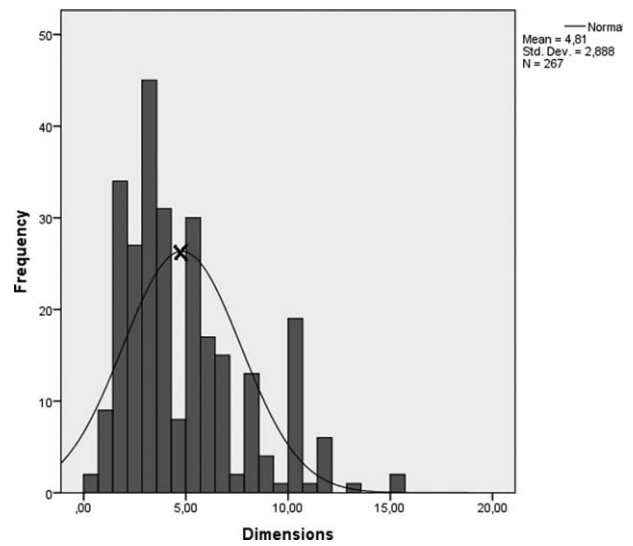


Figure 8. Distribution of diameter of parathyroid cysts.

Concerning treatment, 95.4% of patients with functioning cysts underwent surgical excision and 4.6% FNA, whereas 71.6% of patients with nonfunctioning cyst underwent surgical excision, 21.9% FNA and 6.5% sclerotherapy ($P < .001$), as shown in Fig. 7.

3.6. Size

For the dimensions of PCs, there were data for 267 of 359 patients (74.3%). Mean diameter of the cyst was 4.81 ± 2.88 cm, ranging from 0.5 to 15 cm, as shown in Fig. 8.

We correlated dimensions and clinical presentation of PCs and found that there is no statistically significant difference of the diameter between 2 different categories of clinical presentation ($U = 7617.5$, $P = .187$).

Concerning gender, we concluded that male had bigger cysts than female (male mean rank = 156.55, female mean rank = 121.14, $U = 6058$, $P < .001$). This is demonstrated in Fig. 9.

As far as location is concerned, bigger cysts were located in the middle compartment of mediastinum, followed by the other compartments of mediastinum and then the thyroid lobes ($P < .001$), as shown in Fig. 10.

The correlation made between age and dimensions showed that there is difference between age distribution among dimensions of the PC ($P = .005$).

3.7. Diagnostic methods

As far as diagnostic methods are concerned, the most useful tool has proved to be ultrasound, followed by FNA, as shown in Fig. 11. Other imaging techniques applied were computed tomography (CT) scan and plain radiograph, while surgical exploration is still of great importance for the diagnosis of PCs. Last but not least, magnetic resonance imaging (MRI) and Tc99m scintigraphy can be helpful tools for the differential diagnosis of PCs. In the laboratory tests, 131 of 135 patients (97%) were found to have elevated PTH in cystic fluid, a fact that characterizes PCs.

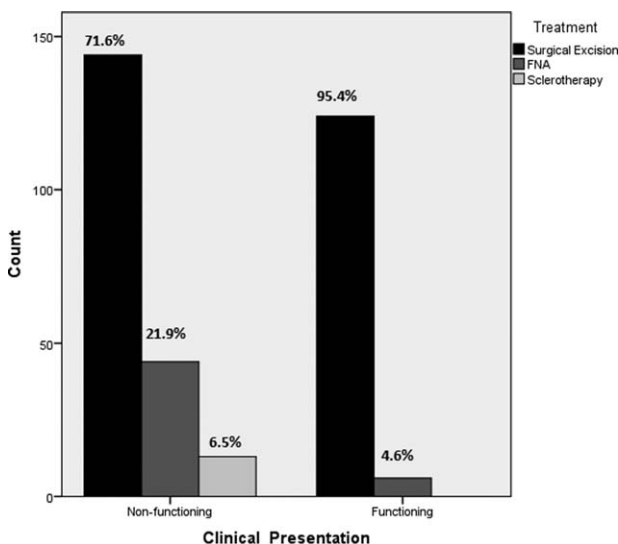


Figure 7. Correlation between treatment and clinical presentation. ($P < .001$).

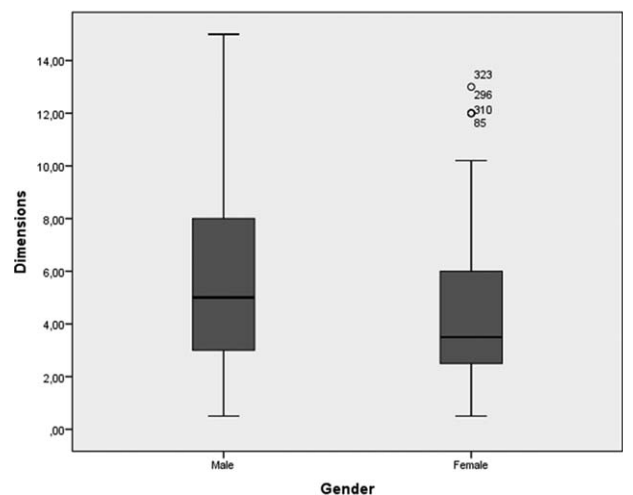


Figure 9. Box-plot demonstrating the distribution of dimensions among males and females. ($P < .001$).

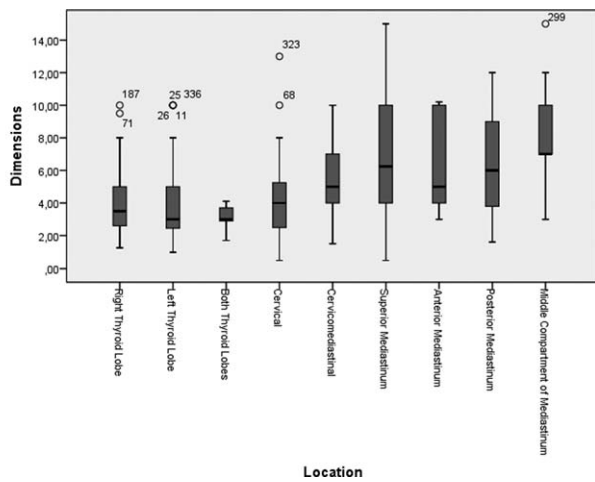


Figure 10. Box-plot demonstrating the distribution of dimensions among different locations of parathyroid cysts. ($P < .001$).

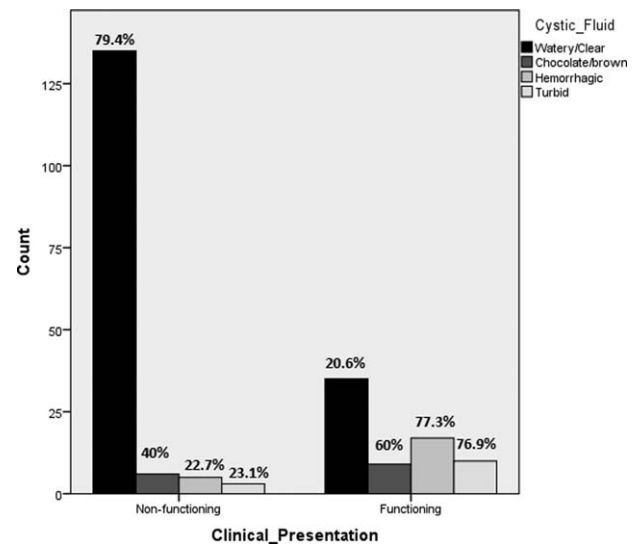


Figure 12. Correlation between clinical presentation and cystic fluid. ($P < .001$).

3.8. Histopathological features

For the histopathology and immunohistochemistry of PCs, the majority of them consist of parathyroid tissue (190/192 patients, 98.9%), while thyroid tissue (9 patients) and thymic tissue (8 patients) can be presented. There were cases that presented fibrosis (43 patients) and bleeding into the cyst (23 patients).

There was not enough information about the immunohistochemical factors of PCs. AE1/2, CAM 5.3, Factor VIII, Calcitonin, LCA, and SMA were stained for 1 patient each. Pancytokeratin was positive for 2 patients, while thyroglobin was positive for 4 patients.

As far as cystic fluid analysis is concerned, there were data for 220 of 359 patients (61.28%), from whom 170 patients (77.3%) had watery/clear fluid, 15 patients (6.8%) had chocolate/brown fluid, 22 patients (10%) had hemorrhagic fluid, and 13 patients (5.9%) had turbid fluid. Concerning clinical presentation, 79.4% of nonfunctioning cysts had watery/clear cystic fluid and 40% chocolate/brown one, whereas 20.6% of functioning cysts had watery/clear cystic fluid and 60% chocolate/brown one ($P < .001$), as shown in Fig. 12.

3.9. Treatment

For the treatment applied, surgical excision has been chosen in 269 of 333 patients (80.8%), whereas FNA has been done in 50 of 333 patients (15%). Sclerotherapy has been chosen in 14 patients (4.2%).

The correlation made between treatment applied and recurrence rate has shown that there is no statistically significant difference between surgical excision and FNA as far as recurrence rate ($P = .590$).

3.10. Hospitalization and follow-up

The mean duration of hospitalization has been found to be 4.76 days, ranging from 1 day to 20 days, but we had data only for 30 of 359 patients (8.35%), so the results are not so reliable. The duration of hospitalization of patients who did not undergo thoracotomy should be only 1 day.

With data for 97 of 359 patients (27%), the mean follow-up period was 17.34 months, ranging from 0 months to 204 months. The cyst recurred in 27 of 97 patients (27.83%).

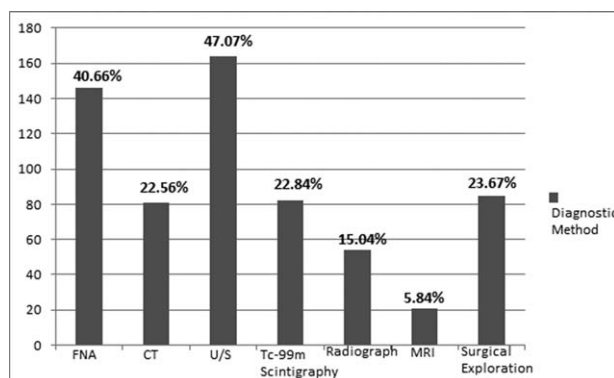


Figure 11. Methods conducted for the diagnosis of parathyroid cysts.

4. Discussion

PCs are uncommon clinical entities, which arise in the neck and the mediastinum. They were first described by Sandström in 1880,^[7] while Goris^[8] (1905) reported their first surgical resection.^[10] DeQuervain^[11] published the first case of a mediastinal PC in 1925, whereas the first functioning PC was described by Greene et al^[12] in 1952.^[13] Noble and Borg^[14] in 1936 was the first who resected surgically a functioning mediastinal PC.^[15] Crile and Perryman (1953)^[16] were the first to publish a case of the correct preoperative diagnosis of a PC using FNA.^[17]

PCs seem to have a female predilection with a male: female ratio 1:3.5 and 1:2.5.^[17-22] PCs more frequently appear in fourth and sixth decades.^[19,21-24] PCs can be subdivided into 2 main categories: functioning and nonfunctioning, regarding their hormone producing activity.^[25-28] Functioning cysts count for 20% of PCs, as they were found in 0.3% to 3% of parathyroid

glands removed due to hyperparathyroidism.^[29] Functioning PCs seem to be found predominantly in male patients (1.6:1), while nonfunctioning ones have a predilection for female.^[10,13,17,27,29–32] Regarding our study, functioning PCs have a similar distribution between male and female, while nonfunctioning ones of female are 2 times more frequent in females.

Jarnagin and Clark^[33] mentioned that the incidence of mediastinal PCs ranges from 2.5% to 22%, while the incidence of sternotomy in such cases ranges from 1.4% to 14%. According to our findings, mediastinal PCs' percentage is much higher and up to 33.5%.

It is important for us to notice that larger parathyroid glands and parathyroid glands of older patients tend to be located in the mediastinum (cervicomediastinal and lower). Both gravity and consistence of the surrounding tissues (less collagen in older people) probably lead to a displacement of the glands to lower positions.

Regarding location of PCs, it extends from the angle of the mandible to the mediastinum.^[26,34–36] The majority of PCs arise from the inferior parathyroid gland.^[15,37] In the literature, there are several reports of both neck and mediastinal PCs, yet with a higher incidence of these in the neck.^[15,38–64] Safran et al^[31] referred to the incidence of neck PCs, which is 85% to 95% and mostly left-sided.^[32,65,66] Furthermore, it is worth mentioning that there is a paucity of intrathyroidal and intrathymic cases of PCs.^[67–76] We found that the larger cysts are pushed lower into the neck, ending up into the mediastinum.

PCs display a great variety of symptoms. The heterogeneous clinical presentation is attributed to the fact that PCs appear in different locations and are of variable functionality. The majority of cases are asymptomatic, presenting with an incidentally found neck mass, which can be palpable and mimic a thyroid nodule.^[13,25,32,77–94] Alvi et al^[18] and Coates et al^[95] reported that larger cysts can cause compressive symptoms and mediastinal ones can cause recurrent laryngeal nerve palsy. Compressive symptoms such as dysphagia, odynophagia, dyspnea, asthma, stridor, hoarseness, vein thrombosis, cough, vomiting, choking sensation are caused by displacement of the adjacent structures.^[5,15,16,19,26,38,51,58,95–113] Furthermore, there are references of vocal cord paralysis due to compression of PCs.^[20,114–117]

On the contrary, PCs may present with hyperparathyroidism, hypercalcemia and hypophosphatemia, nephrolithiasis, constipation, mental disturbances, depression, weight loss or obesity and fatigue, bone changes, osteomalacia, or there are only incidental laboratory findings.^[14,22,25,29,35,69,77,113,118–141] In the majority of these cases, the cause of this parathyroid dysfunction is an adenoma, which coexisted with the PC or degenerated into a PC. PCs remain a rare cause of hyperparathyroidism.^[139,142–144] Fallon et al^[145] reported 1 case of parathyroid gland hyperplasia instead of adenomas. Several cases of acute symptomatology, caused by hypercalcemic crisis or compression of adjacent structures, which are life-threatening conditions, have been reported in the literature.^[146–153] Furthermore, hemorrhage into the PC has been reported and Manouras et al mentioned a case of bleeding into the cyst that caused acute hypercalcemic crisis.^[15,102,129,143,149,154,155] Taniguchi et al^[156] reported a case of a cervical hematoma caused by a PC. Glynn et al^[157] published a case of multiple PCs. Cases of coexistence of PCs with other conditions such as pheochromocytoma and MEN-1 syndrome have been reported.^[158,159]

Our study supported the assumption that the most common clinical manifestation of PCs is an asymptomatic neck mass, while compressive symptoms are the second most frequent clinical presentation.

PCs occur rarely in children. According to the present review, only 4 cases have been reported, accounting for 1% of PCs.^[42,98,160,161]

The differential diagnosis of a PC includes a wide range of neck and mediastinal masses. PCs should be considered in the differential diagnosis of neck masses.^[160]

Therefore, in the differential diagnosis of PCs, one must consider thyroid goiter, thyroid cyst, thymic cyst, thyroid adenoma, and parathyroid carcinoma.^[2,6,10,50,57,125,143,152,162–173] Furthermore, thyroglossal duct cyst and branchial cleft cyst should be taken into consideration as neck masses that usually mimic PCs. Multiple studies support the assumption that test of the cystic fluid aspirated by FNA is the best method to distinguish PCs. PCs contain clear-watery fluid. Moreover, PCs contain high concentrations of PTH.^[18,170,174–178]

As far the mediastinal PCs is concerned, they should be distinguished from vascular lesions, teratomas, lipomas, adenopathy, neuromas, thymomas, bronchogenic cysts, lymphangiomas, cystic hygromas, cysts and tumors of esophagus, trachea, nerves, lymphatics, and thyroid and parathyroid glands.^[24,35,37,47,56,165,167,170,179] Imaging examinations and especially CT scan can differentiate vascular, solid, and cystic structures.^[47,179] Aortography was used in a case of PC in order to be differentiated by vascular abnormalities.^[92] Spitz^[180] suggested that mediastinal malignancies and metastases should be considered in the differential diagnosis, especially in the elderly.

The diagnosis of PCs is far more characterized as a postoperative rather than preoperative one.^[77,91,98,181,182] However, references in the literature reveal that there are several cases of PCs, which have been diagnosed preoperatively.^[16,24,27,65,170,183,184] Hauet et al^[165] suggested that the final diagnosis of PCs is based on biopsy. Korukluoglu et al^[69] mentioned that a preoperative localization of the PC using scintigraphy or ultrasound would help in order that the bilateral neck surgical exploration is avoided.

On physical examination, PCs appear to be palpable firm, smooth, solitary, nontender lesions located in the neck or superior mediastinum.^[65]

The main imaging techniques that are used for the diagnosis of PCs are plain radiograph, CT scan, MRI, technetium radionuclide scintigraphy (Tc-scintigraphy), and ultrasound. Plain radiograph are usually used when the cyst is located in the mediastinum or lower neck.^[55,185] CT and MRI scan has nonspecific findings, but they can easily reveal homogenous areas of cystic nature and are useful tools for the diagnosis, especially when there is symptomatology of vocal cord paralysis or if the cyst is mediastinal.^[45,47,54,55,58,117,131,148,166,167,186–188] The neck ultrasound examination is of great importance for the evaluation of PCs, as it reveals the cystic nature of the mass and its dimensions, is easily done and can be combined with FNA aspiration fluid.^[3,21,44,50,69,131,143,148,151,168,171,185–187,189–194]

Microscopically, PCs are lined by cuboidal or columnar epithelium and are thin-walled white cysts.^[15,22,117,139,162,195,196] Furthermore, other tissues such as thymic, bone, lymphoid, muscular, adipose, salivary, and mesenchymal can be found in the cyst wall.^[27,111,147,196–199] This pathology refers mainly to nonfunctioning cysts, whereas functioning ones lack this epithelium and are characterized more as pseudo-cysts.^[2,92,131,200] Kuo et al^[201] reported a case of an adenoma found lined in the cyst wall, surrounded by cuboid cells. References in the literature reveal that hyperfunctioning PCs can be formed by adenomatous tissue without any evidence of

adenoma or hyperplasia.^[202] A case of a carcinoma found in a PC has been reported.^[203]

The cytological analysis of the cyst fluid includes the presence of small clusters of epithelial cells and fibroblasts, which are atypically proliferated and are mistaken for malignant cells. The fluid is colorless, clear-watery with high concentrations of CMPTH.^[204–207] Although, it can also be hemorrhagic, most in cases of hemorrhage of an adenoma.^[4,108] One case of high concentrations of ca19–9 in the cystic fluid has been reported.^[208]

Immunohistochemically, PCs stain positive for parathormone-peptide, glycogen, and focally for chromogranin.^[115,195]

The initial treatment of PCs is FNA, and in case of recurrence, surgical excision is recommended as the definitive treatment.^[3,17,18,32,39,54,67,100,103,121,160,164,171,180,211–213] A retrospective study carried out by Ippolito et al^[198] have shown that from 14 patients who underwent FNA as initial treatment, 4 have a recurrence and a surgical excision followed. Until late 1970s, when Clark et al^[65] first cured a PC with FNA, surgery was the main treatment. After then, several cases of PC were treated only with FNA.^[175,177,214,215]

In 1992, Okamura et al^[216] suggested the injection of sclerosants as an alternative treatment of PCs. This technique was especially used in case of a recurrence of PCs after FNA in order that open surgery is avoided.^[17,172,200,212,214] In the literature, there are several reports of sclerotherapy with tetracycline or ethanol injection used as treatment of PCs, especially in nonfunctioning ones.^[170,178,217–219]

According to the clinical presentation of PCs, non-functioning ones are treated with FNA, whereas functioning ones with surgical excision.^[71,131,187,194,195,200,211,220,221] Mevio et al^[187] and Béquignon et al^[194] mentioned that nonfunctioning ones that recur or appear with compressive symptoms should be excised. Capezzone et al^[67] added another reason for surgical excision of nonfunctioning PCs, which is esthetic concerns. Yang et al^[222] reported a case series of 6 patients with nonfunctioning cysts who underwent surgical excision and no recurrence was documented within 2 to 9 years of follow-up. The main indications for surgery reported in the literature are hyperparathyroidism-functioning cysts, uncertain diagnosis of PCs, possibility for malignancy, presence of symptoms, and recurrences.^[209,210] The intraoperative characteristics of the cyst that required surgical excision are the cyst is attached to the thyroid gland, the cyst wall has a whitish color and the cyst content is clear watery fluid, and the cyst is located in the lower neck.^[39,183]

Concerning the correct exeresis of the hyperfunctioning gland, we used the Miami criteria as per every hyperfunctioning parathyroid.

All the above treatments have their complications. Hemorrhage is reported as an early complication of FNA, while recurrence can occur as a late one.^[200] After surgical excision of PCs, hypocalcemia, hypercalcemic crisis, hemorrhage, and recurrent laryngeal nerve palsy have been referred as postoperative complications.^[18,65,172,195] Neck pain and neurotoxicity leading to recurrent laryngeal nerve palsy seem to have an association with sclerotherapy.^[172,210]

We have however to comment a technical aspect probably leads to recurrence at the surgical technique. Those cysts have a very thin wall, and therefore, it is very difficult to excise them as a whole and without rupture. We would therefore consider the rupture of the cyst and its incomplete excision as the reason of recurrence.

In general, the prognosis is excellent in PCs. No recurrences or metastasis is observed, except for 14 cases of patients, from

whom 10 patients appeared with 1 recurrence, 3 with 2 recurrences, and 1 with 3 recurrences within their follow-up period.^[2,40,54,65,166,169,170,210,215,220,223,224] These recurrences appeared after the first FNA and surgical excision was mandatory as their definitive treatment. According to a study published by Lorenzo et al^[224] in 2008, malignant transformation has not been noted in 10 years follow-up of a case of a recurrent PC, which needed repeated FNA due to patient's rejection to be operated. In the literature, there are no reports of malignancy of PCs.^[18,160] No deaths have been noted due to PC and long-term survival of patient seems to be certain.^[37,51]

5. Conclusion

We conclude that PCs are included in parathyroid glands' pathologies and should be taken into consideration in case of parathyroid dysfunction as well as in differential diagnosis of asymptomatic neck masses. Neck ultrasound accompanied by FNA and fluid analysis (fluid PTH measurement) are useful tools in the diagnosis of PCs. When surgical excision is chosen as the appropriate treatment, the surgeon's careful manipulations on the cyst, so that rupture is avoided, are crucial for a definitive treatment.

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References

- [1] Cappelli C, Rotondi M, Pirola I, et al. Prevalence of parathyroid cysts by neck ultrasound scan in unselected patients. *J Endocrinol Invest* 2009;32:357–9.
- [2] Arduc A, Tutuncu YA, Dogan BA, et al. Parathyroid cysts. *Am Surg* 2015;81:e163–5.
- [3] Ciuni R, Ciuni S, Monaco G, et al. Parathyroid cyst: a case report. *Ann Ital Chir* 2010;81:49–52.
- [4] Lerud KS, Tabbara SO, DelVecchio DM, et al. Cytomorphology of cystic parathyroid lesions: report of four cases evaluated preoperatively by fine-needle aspiration. *Diagn Cytopathol* 1996;15:306–11.
- [5] Delaunay T, Peillon C, Manourvrièr JL, et al. Les kystes des parathyroïdes: a propos de six cas. [The parathyroid cysts: report of six cases]. *Ann Chir* 1990;44:231–5.
- [6] Silverman J, Khazanie P, Norris HT, et al. Parathyroid hormone (PTH) assay of parathyroid cysts examined by fine-needle aspiration biopsy. *Am J Clin Pathol* 1986;86:776–80.
- [7] Sandström I. On a new gland in man and several mammals. *Upsala Lak Foren Forh* 1879;15:441.
- [8] Goris D. Extirpation of three cystic parathyroid lobules. *Ann Soc Belge Chir* 1905;5:394.

- [9] Peat J, Barton B. *Medical Statistics. A Guide to Data Analysis and Critical Appraisal*. 2005;Blackwell Publishing, 24–241.
- [10] Oh A, Mojica P, Sullivan M, et al. Malignant hypercalcemia associated with a parathyroid macrocyst and the early genesis of a giant cell tumor. *Am J Otolaryngol* 2006;27:54–7.
- [11] deQuervain F. Chirugishe demonstrationen (Epithel-Kuperchen-Cysti). *Schweiz Med Wochenschr* 1925;55:1169.
- [12] Greene EK, Greene JM, Busch EC. Unusual manifestations after removal of parathyroid cyst. *JAMA* 1952;150:853–5.
- [13] Linos DA, Schoretsanitis G, Carvounis E. Parathyroid cysts of the neck and mediastinum: case report. *Acta Chir Scand* 1989;155:211–6.
- [14] Noble JF, Borg JF. Hyperparathyroidism complicated by hyperthyroidism. Report of a case. *Arch Intern Med* 1936;58:846–59.
- [15] McKay GD, Ng TH, Morgan GJ, et al. Giant functioning parathyroid cyst presenting as a retrosternal goitre. *ANZ J Surg* 2007;77:297–304.
- [16] Crile GJ, Perryman RG. Parathyroid cysts. Report of five cases. *Surgery* 1953;14:151–4.
- [17] Pinney S, Daly P. Parathyroid cyst: an uncommon cause of a palpable neck mass and hypercalcemia. *West J Med* 1999;170:118–20.
- [18] Alvi A, Myssiorek D, Wasserman P. Parathyroid cyst: current diagnostic and management principles. *Head Neck* 1996;18:370–3.
- [19] Asfar S, Smith G, Krukowski Z. Parathyroid cysts. *World J Surg* 1982;6:777–81.
- [20] Coelho DH, Boey HP. Benign parathyroid cyst causing vocal fold paralysis: a case report and review of the literature. *Head Neck* 2006;28:564–6.
- [21] DeRaimo AJ, Kane RA, Katz JF, et al. Parathyroid cyst: diagnosis by sonography and needle aspiration. *AJR Am J Roentgenol* 1984;142:1227–8.
- [22] Grunberg W, Domingo OH. Parathyroid cyst. *Am Surg* 2013;77:e256–7.
- [23] Koea JB, Shaw JHF. Parathyroid cyst and hyperparathyroidism in Auckland. *N Z Med J* 1988;101:655–6.
- [24] Wood J, Johnson K, Hinds M. Parathyroid cysts. *Arch Surg* 1966;92:785–90.
- [25] Downey RJ, Cerfolio RJ, Deschamps C, et al. Mediastinal parathyroid cysts. *Mayo Clin Proc* 1995;70:946–50.
- [26] Agrawal D, Lahiri TK, Agrawal A, et al. Uncommon parathyroid mediastinal cyst compressing the trachea. *Indian J Chest Dis Allied Sci* 2006;48:279–81.
- [27] Rosenberg J, Orlando R, Ludwig M, et al. Parathyroid cysts. *Am J Surg* 1982;143:474–80.
- [28] Van Fossen V, Edis A. Clear parathyroid cysts and hyperparathyroidism. *Am Surg* 1998;64:1226–8.
- [29] Karras S, Koutelidakis I, Anagnostis P, et al. A rare case of a parathyroid adenoma inside a parathyroid cyst. *Arq Bras Endocrinol Metabol* 2014;58:776–8.
- [30] Page GV, Burke ML, Metzger WT. Parathyroid cysts. *Am Surg* 1984;50:29–32.
- [31] Safran D. Functioning parathyroid cyst. *South Med J* 1998;91:978–80.
- [32] Mitmaker B, Lerman S, Lamoureux E, et al. Parathyroid cyst: diagnosis and treatment of an unusual surgical problem. *Can J Surg* 1991;34:59–61.
- [33] Jarnagin W, Clark OH. Mediastinal parathyroid cyst causing persistent hyperparathyroidism: case report and review of the literature. *Surgery* 1997;123:709–11.
- [34] Saha AR. Parathyroid re-exploration. *Otolaryngol Clin North Am* 2004;37:833–43.
- [35] Seltzer SE, Balikian JP, Birnholz JC, et al. Giant hyperplastic parathyroid gland in the mediastinum—partially cystic and calcified. *Radiology* 1978;127:43–4.
- [36] Buchanan G, Gregory MM. Giant functioning cervicomedial parathyroid cyst. *Ann Otol Rhinol Laryngol* 1979;88:545–9.
- [37] Shields TW, Immerman SC. Mediastinal parathyroid cysts revisited. *Ann Thorac Surg* 1999;67:581–90.
- [38] Haid SP, Method HL, Beal JM. Parathyroid cysts. Report of two cases and a review of the literature. *Arch Surg* 1967;94:421–6.
- [39] Jha BA, Nagarkar NM, Kochhar S, et al. Parathyroid cyst: a rare cause of an anterior neck mass. *J Laryngol Otol* 1999;113:73–5.
- [40] Matton G. A giant nonfunctioning parathyroid cyst. *Eur J Plast Surg* 1991;14:94–6.
- [41] Mills KA, Aanning HL. Parathyroid cyst: case report of a rare surgical lesion of the neck. *S D J Med* 1990;43:15–7.
- [42] Mosso L, López JM, Trincado P, et al. [Functioning and non-functioning parathyroid cysts: entities with different origin and clinical characteristics in 2 cases]. [Article in Spanish]. *Rev Med Chil* 1997;125:1049–54.
- [43] Pai RR, Verghese R, Pai KR, et al. Parathyroid cyst: a rare case report. *Indian J Pathol Microbiol* 1996;39:297–8.
- [44] Sunose H. A case of nonfunctioning parathyroid cyst. *Otolaryngol Head Neck Surg (Tokyo)* 1999;71:477–80.
- [45] Virbalas J, Ransom E, Kacker A. Radiology quiz case 1. Diagnosis: parathyroid cyst (PC). *Arch Otolaryngol Head Neck Surg* 2010;136:924, 926–927.
- [46] Codreanu C, Codreanu CM. Parathyroid cysts; a rare condition: a case report and review of the literature. *Chirurgia (Bucur)* 2011;106:127–9.
- [47] Colledge D, Rohatgi P. Mediastinal parathyroid cyst. *J Comput Assist Tomogr* 1983;7:140–2.
- [48] Furuya S, Mimura T, Matsuoka H, et al. Parathyroid cyst and cervical thymic cyst. *Horumon to Rinsho* 1970;18:1015–20.
- [49] Freeman JB, Sherman BM, Mason EE. Transcervical thymectomy: an integral part of neck exploration for hyperparathyroidism. *Arch Surg* 1976;111:359–64.
- [50] Elizondo E, Amondarain M, José A. Parathyroid cyst and hyperparathyroidism. *Surgery* 2008;143:447–8.
- [51] Davoli F, Rena O, Pirondini E, et al. Giant functioning mediastinal parathyroid cyst: an unusual cause of exertional dyspnea and mild dysphagia. *Arch Bronconeumol* 2013;49:408–12.
- [52] Cruse C, Daouk A. Mediastinal parathyroid cyst report of a case and review of the literature. *Am J Surg* 1978;135:714–6.
- [53] Thomas de Montpréville V, Darteville P, Dulmet E. [Parathyroid cyst of the anterior mediastinum]. [Article in French]. *Ann Pathol* 1983;13:247–9.
- [54] Gough I. Parathyroid cysts. *Aust N Z J Surg* 1999;69:404–6.
- [55] Hirano H, Miyamoto Y, Tsubota N, et al. [Two patients with mediastinal parathyroid cysts]. [Article in Japanese]. *Nihon Kyobu Shikkan Gakkai Zasshi* 1997;35:82–8.
- [56] Hoskuldssdottir A, Kristvinsson H, Gudjonsson H, et al. [Mediastinal parathyroid cyst: a case report]. [Article in Icelandic]. *Laeknabladid* 2014;100:453–5.
- [57] Petri N, Holten I. Parathyroid cyst: report of case in the mediastinum. *J Laryngol Otol* 1990;104:56–7.
- [58] Shishido M, Nagao M. [Parathyroid cyst presenting as a mediastinal tumor]. [Article in Japanese]. *Nihon Kyobu Shikkan Gakkai Zasshi* 1996;34:894–7.
- [59] Supic O, Stepanov S. Parathyroid gland cyst as an unusual cause of superior mediastinal mass. *Arch Oncol* 2003;11:25–6.
- [60] Togashi K, Sato Y, Yazawa M. [Mediastinal parathyroid cyst]. [Article in Japanese]. *Nihon Kyobu Geka Gakkai Zasshi* 1991;39:117–20.
- [61] Matsuoka H, Tsubota N, Yoshimura M. Mediastinal parathyroid cyst: a case report and review of the literature. *Nippon Kokyuki Geka Gakkai Zasshi* 1991;5:420–4.
- [62] Akiyama S. A case of parathyroid cyst in the mediastinum. *J Jpn Surg Assoc* 1987;48:1359.
- [63] Alonso K, Podobnikar M, Haraszti AS. Parathyroid cysts. *J Med Assoc Ga* 1984;73:231–2.
- [64] Pascual LG, Canonge RS, Alfonso GO, et al. Parathyroid cysts. *Med Clin* 1990;94:518.
- [65] Clark OH. Parathyroid cysts. *Am J Surg* 1978;135:395–402.
- [66] Calandra DB, Shah KH, Prinz RA, et al. Parathyroid cysts: a report of eleven cases including two associated with hyperparathyroid crisis. *Surgery* 1983;94:887–92.
- [67] Capezone M, Morabito E, Bellitti P, et al. Ectopic intrathyroidal nonfunctioning parathyroid cyst. *Endocr Pract* 2007;13:56–8.
- [68] Atwan M, Chetty R. An unusual “thyroid cyst”: intrathyroidal parathyroid cyst. *Endocr Pathol* 2011;22:108–11.
- [69] Korukluoglu B, Ergul E, Yalcin S. Giant intrathyroidal parathyroid cyst adenoma. *J Pak Med Assoc* 2008;58:592.
- [70] Hoi WH, Leow MKS, Sule A, et al. Hyperparathyroidism due to ectopic PTH secretion from an ectopic intrathyroidal parathyroid cyst. *Ann Thorac Cardiovasc Surg* 2011;17:511–3.
- [71] McCluggage WG, Russell CFJ, Toner PG. Parathyroid cyst -of the thymus. *Thorax* 1995;50:913–4.
- [72] Pyrtek LJ. Parathyroid cysts. In discussion of Rosenberg J, Orlando R, Ludwig M, Pyrtek LJ. *Am J Surg* 1982;143:473–80.
- [73] Bondeson AG, Thompson NW. Mediastinal Parathyroid Adenomas and Carcinomas. Lea and Febiger, Philadelphia, PA:1991.
- [74] Casella C, Della Casa D, Baronchelli C, et al. [Giant intrathyroidal parathyroid cyst with hyperparathyroidism: a case report]. Article in Italian. *Ann Ital Chir* 2005;76:391–4.
- [75] Gayatri P, Sanjay D, Ajay N, et al. Mixed multilobular ectopic thymic cyst with parathyroid element presenting as neck mass. *Ann Acad Med* 2012;41:271–2.

- [76] Rickels MR, Langer JE, Mandel SJ. Hyperfunctioning intrathyroidal parathyroid cyst. *J Clin Endocrinol Metab* 2004;89:1051–2.
- [77] Altun H, Özdemir A, Hamaloglu E, et al. Hyperfunctioning parathyroid cysts: a case report. *Acta Chir Belg* 2004;104:234–6.
- [78] Abdou AG, Kandil MA. A case of amyloid goiter associated with intrathyroidal parathyroid and lymphoepithelial cyst. *Endocr Pathol* 2009;20:243–8.
- [79] McGoon DC, Cooley DA. Parathyroid cyst: an unusual cervical tumor. Report of 3 cases. *Surgery* 1951;30:725–32.
- [80] Johnsrud RL. In discussion of Fratkin LB. Parathyroid cyst: report of four cases. *Am Surg* 1965;31:420–8.
- [81] Thacker WC, Wells VH, Hall ER. Parathyroid cyst of the mediastinum. *Ann Surg* 1971;174:969–75.
- [82] Hattori Y. Nonfunctioning parathyroid cyst in the mediastinum. *J Jpn Assoc Chest Surg* 1998;12:543–8.
- [83] Maxwell DB, Horn RCJ, Rhoads JE. Cysts of the parathyroid. Report of three cases clinically simulating nodular goiter. *Arch Surg* 1952;64:208–13.
- [84] Welti MH. A propos des kystes parathyroïdiens [Report of parathyroid cysts]. *Mem Acad Chir* 1946;72:33–5.
- [85] Ishida T, Hosono T, Inoue K, et al. Nonfunctional parathyroid cysts—report of four cases and review of the Japanese literature. *Horumon to Rinsho* 1983;31:861–7.
- [86] Katz AD, Dunkleman D. Needle aspiration of nonfunctioning parathyroid cysts. *Arch Surg* 1984;119:307–8.
- [87] Higgins GA. Mediastinal parathyroid tumors [In discussion of Clark OH]. *Arch Surg* 1988;123:1096–100.
- [88] Kawashima Y. A case of non-functioning parathyroid cyst which was thought as a mediastinal tumor. *Horumon to Rinsho* 1988;36:473–5.
- [89] Hughes CR, Kanmaz B, Isitman AT, et al. Misleading imaging results in the diagnosis of parathyroid cysts. *Clin Nucl Med* 1994;19:422–5.
- [90] Kumeda S, Kondo R, Watanabe H. A case of giant parathyroid cyst in the superior mediastinum. *Nihon Rinsho Gekai Gekka Zasshi. J Jpn Clin Surg Assoc* 1996;57(suppl):269.
- [91] Jaroszewicz S, Cyrylowski L, Chosia M, et al. Asymptomatic parathyroid cyst: diagnostic difficulties (a case report). *Acta Chir Hung* 1998;37:227–33.
- [92] Kooy RG, Ghislandi EV. Macrocysts of the parathyroids. *IMJ Ill Med J* 1979;156:171–3.
- [93] Markalou B, Svarovsky J, Suchomelova J. Cysts of parathyroid glands. *Otorinolaryngol Prague* 1997;46:122–6.
- [94] Fustar Preradovic L, Danic D, Dzodic R. Small nonfunctional parathyroid cysts: single institution experience. *Endocr J* 2017;64:151–6.
- [95] Coates G, Pearman K, Holl-Allen RTJ. Recurrent nerve palsy due to parathyroid cyst. *Int Surg* 1991;76:192–3.
- [96] Dell'Amore A, Asadi N, Bartalena T, et al. Thoracoscopic resection of a giant mediastinal parathyroid cyst. *Gen Thorac Cardiovasc Surg* 2014;62:444–50.
- [97] Guvendik L, Oo LK, Roy S, et al. Management of a mediastinal cyst causing hyperparathyroidism and tracheal obstruction. *Ann Thorac Surg* 1993;55:167–8.
- [98] Haque W, Roberts J, Dishop M, et al. Asthma secondary to tracheal obstruction by parathyroid cyst. *Int J Pediatr Otorhinolaryngol Extra* 2010;5:131–3.
- [99] Orrego J. Visual vignette. Parathyroid cyst. *Endocr Pract* 2005;11:292.
- [100] Pérez JA, Poblete MT, Salem C. [Symptomatic parathyroid cysts. Report of one case] [Article in Spanish]. *Rev Med Chil* 2003;131:432–5.
- [101] Saberi S, Doherty GM, Esfandiari NH. Stridor due to an unsuspected parathyroid cyst in a thirty-two-year-old woman with goiter. *Thyroid* 2010;20:1315–6.
- [102] Shibata H, Kuze B, Hayashi H, et al. [A case of idiopathic neck bleeding from a parathyroid cyst] [Article in Japanese]. *Nihon Jibiinkoka Gakkai Kaiho* 2014;117:1194–9.
- [103] Umemori Y, Makihara S, Kotani K, et al. Mediastinal parathyroid cyst with tracheal constriction. *Jpn J Thorac Cardiovasc Surg* 2002;50:85–7.
- [104] Hayashi S. A case of parathyroid cyst in the mediastinum. *Nihon-Kyobu Rinsho* 1966;25:350–4.
- [105] Narita Y. A case of parathyroid cyst in the mediastinum. *Rinsho Geka* 1992;47:525–8.
- [106] Takahashi E, Kohno A, Narimatsu A, et al. A case of mediastinal parathyroid cyst. *Jpn J Clin Radiol* 1988;33:393–6.
- [107] Carlier M, Van Geertruyden J. Kyste parathyroïdien me' diastinal [Mediastinal parathyroid cyst]. *Sem Hopitaux Paris* 1981;57:501–4.
- [108] Marco V, Carrasco MA, Marco C, et al. Cytomorphology of a mediastinal parathyroid cyst. Report of a case mimicking malignancy. *Acta Cytol* 1983;27:688–92.
- [109] Sutherland WH, McKenzie AD. In discussion of Fratkin LB. Parathyroid cyst: report of four cases. *Am Surg* 1965;31:420–8.
- [110] Beahrs OH, Devine KD. Unusual diagnostic problems in the neck. *Surg Clin North Am* 1961;41:1069–75.
- [111] Welti H, Gerard-Marchant R. Propos de cinq nouvelles observations de kyste parathyroïdien [Report of five new observations of parathyroid cysts]. *Mem Acad Chir* 1956;82:994–1001.
- [112] Darras T, Lenaerts L, Jaucot J, et al. Acutely symptomatic benign mediastinal cysts. *J Belge Radiol* 1992;75:111–4.
- [113] Korhonen T, Alhava E, Seppä A, et al. [Hyperparathyroidism and large parathyroid cyst]. Article in Finnish. *Duodecim* 1985;101:1380–2.
- [114] Grey AB, Shaw J, Anderson N, et al. Parathyroid cyst with recurrent vocal cord paresis. *Aust N Z J Surg* 1993;63:561–2.
- [115] Landau O, Chamberlain DW, Kennedy RS, et al. Mediastinal parathyroid cysts. *Ann Thorac Surg* 1997;63:951–3.
- [116] Sen P, Flower N, Papesch M, et al. A benign parathyroid cyst presenting with hoarse voice. *J Laryngol Otol* 2000;114:147–8.
- [117] Woo EK, Simo R, Conn B, et al. Vocal cord paralysis secondary to a benign parathyroid cyst: a case report with clinical, imaging and pathological findings (2008:6b). *Eur Radiol* 2008;18:2015–8.
- [118] Cao H, Lai C, Head C, et al. Cystic parathyroid presenting as an apparent thyroid goiter. *Eur Arch Otorhinolaryngol* 2008;265:1285–8.
- [119] Albertson D, Marshall R, Jarman W. Hypercalcemic crisis secondary to a functioning parathyroid cyst. *Am J Surg* 1981;141:175–7.
- [120] Ak I, Acikalin MF. Hyperparathyroidism with a functioning parathyroid cyst. *Clin Nucl Med* 2007;32:713–5.
- [121] Arratibell JA, Aribé X, Olalla C, et al. Quiste paratiroideo e hiperparatiroidismo. *Cir Esp* 2008;83:94–100.
- [122] Howell A, Gumpel JM, Hoffenberg R. Occult hyperparathyroidism presenting as a parathyroid cyst. *Proc R Soc Med* 1972;65:881–2.
- [123] Inoue H, Wakabayashi Y, Konishi T, et al. [A parathyroid cyst and an adenoma associated with primary hyperparathyroidism: report of a case] [Article in Japanese]. *Hinyokika Kyo* 1990;36:1197–202.
- [124] Kasperk C, Buhr H, Raue F, et al. [Endocrinously active parathyroid cysts. Their diagnosis by the determination of intact parathormone in the cyst fluid] [Article in German]. *Dtsch Med Wochenschr* 1992;117:1093–6.
- [125] Ardito G, Fadda G, Danese D, et al. Coexistence of a parathyroid adenoma and parathyroid cyst causing primary hyperparathyroidism. *J Endocrinol Invest* 2003;26:679–82.
- [126] Kameyaga K, Mori K. Parathyroid cyst and multicystic parathyroid adenoma. *Acta Pathol Jpn* 1962;12:99–103.
- [127] Kinoshita Y, Nonaka H, Yamaguchi H, et al. [A case of multiple endocrine neoplasia type 1 with growth hormone and prolactin secreting pituitary adenoma, functioning large parathyroid cyst, and Zollinger-Ellison syndrome] [Article in Japanese]. *Nihon Naika Gakkai Zasshi* 1986;75:512–21.
- [128] Vazquez FJ, Aparicio LS, Gallo CG, et al. Parathyroid carcinoma presenting as a giant mediastinal retrotracheal functioning cyst. *Singapore Med J* 2007;48:e304–7.
- [129] Simcic KJ, McDermott MT, Crawford GJ, et al. Massive extracapsular hemorrhage from a parathyroid cyst. *Arch Surg* 1989;124:1347–50.
- [130] Sugimoto K, Umekawa T, Kurita T. [A case of functioning parathyroid cyst] [Article in Japanese]. *Hinyokika Kyo* 1997;43:903–6.
- [131] Tsujikawa K, Kobayashi Y, Yamaguchi S, et al. [A case of functioning parathyroid cyst] [Article in Japanese]. *Hinyokika Kyo* 1999;45:547–9.
- [132] Mizutani S, Sonoda T, Ohkawa T, et al. Macroscopic parathyroid cysts with primary hyperparathyroidism: report of a case. *Hinyokika Kyo* 1962;8:229–305.
- [133] Margolis IB, Wayne R, Organ CH. Parathyroid cysts: functional and mediastinal. *Surgery* 1975;77:462–6.
- [134] Greer DB. Giant parathyroid adenoma: case presentation. *Rocky Mountain Med J* 1967;64:92–4.
- [135] Daggett P, Johnston IDA, Lowe D. A large intrathoracic parathyroid adenoma. *Thorax* 1976;31:782–5.
- [136] Shimizu M, Akamatsu H, Yoshizaki T, et al. Thoracoscopic resection of mediastinal parathyroid adenoma with cyst and hyperparathyroidism: a case report. *Nippon Kyobu Geka Gakkai Zasshi* 1997;45:1972–5.
- [137] Ohi S, Ohta S, Murakoshi K. A case of mediastinal parathyroid cyst. *Haigan (Jpn J Lung Cancer)* 1993;33(suppl 5):793.

- [138] Chimenes H, Moreaux J, Lefrileux CH, et al. Adenome parathyroïdien a symptomatologie re - nale pure chez une femme enceinte. Guérison chirurgicale. Dosage de la parathormone dans le liquide de l'adénome kystique [Parathyroid adenoma with purely renal symptoms in a pregnant woman. Surgical cure. Estimation of parathormone in the cystic adenoma liquid]. *Ann Endocrinol (Paris)* 1963;24:642–9.
- [139] Klein E, Yelin A, Ben-Ari G. Parathyroid cyst and hyperparathyroidism. *Int Surg* 1979;64:79–81.
- [140] Zafon C, Simo R, Baena JA, et al. Hiperparatiroidismo por quiste gigante de paratiroides [Hyperparathyroidism from giant parathyroid cyst]. *Med Clin* 1997;109:198.
- [141] Simkin EP. Hyperparathyroidism associated with a parathyroid cyst: an unusual presentation. *Br J Surg* 1976;63:927–8.
- [142] Gooding GA. Sonography of thyroid and parathyroid. *Radiol Clin North Am* 1993;31:967–89.
- [143] Gooding G, Quan-Yang Duh QY. Primary hyperparathyroidism: functioning hemorrhagic parathyroid cyst. *J Clin Ultrasound* 1997;25:82–4.
- [144] Arnaud C, Walker J, Ewer R. Primary hyperparathyroidism associated with a cystic lesion in the neck: probable parathyroid cyst. *J Clin Endocrinol Metab* 1961;21:833–8.
- [145] Fallon M, Haines J, Teitelbaum S. Cystic parathyroid gland hyperplasia—hyperparathyroidism presenting as a neck mass. *Am J Clin Pathol* 1982;77:104–7.
- [146] Gattas N, Solt I, Loberant N, et al. [Parathyroid cyst associated with acute respiratory failure and jugular vein thrombosis] [Article in Hebrew]. *Harefuah* 2007;146:599–601.
- [147] Gurbuz AT, Peetz M. Giant mediastinal parathyroid cyst: an unusual cause of hypercalcemic crisis report and review of the literature case. *Surgery* 1996;120:795–800.
- [148] Hongo F, Fujito A, Kato J, et al. [Two cases of functioning parathyroid cysts] [Article in Japanese]. *Hinyokika Kiyo* 1998;44:661–5.
- [149] Manouras A, Toutouzas KG, Markogiannakis H, et al. Intracystic hemorrhage in a mediastinal cystic adenoma causing parathyrototoxic crisis. *Head Neck* 2008;30:127–31.
- [150] SerraSolera G, Fernández HG, Juanalsa JQ, et al. Parathyroid crisis due to a cystic parathyroid adenoma. *Endocrinol Nutr* 2011;58:148–51.
- [151] Zhu Y, Li N, Lu L, et al. Hypercalcemic crisis due to a mediastinal parathyroid cyst diagnosed by ultrasound-guided fine needle aspiration. *Chin Med J* 2010;123:3731–3.
- [152] Wirowski D, Wicke C, Bohner H, et al. Presentation of 6 cases with parathyroid cysts and discussion of the literature. *Exp Clin Endocrinol Diabetes* 2008;116:501–6.
- [153] Fahey TJ, Hibbert E, Brady P, et al. Giant double parathyroid adenoma presenting as a hypercalcemic crisis. *Aust N Z J Surg* 1995;65:292–4.
- [154] Dick JA, Brame KG, Owen WJ. Spontaneous bleeding into a parathyroid cyst. *Br J Surg* 1985;72:693.
- [155] Ozaki O, Sakamoto M, Matsui Y, et al. Spontaneous remission of hypercalcemia in a functioning parathyroid cyst. *Jpn J Surg* 1984;14:315–9.
- [156] Taniguchi I, Maeda T, Morimoto K, et al. Spontaneous retropharyngeal hematoma of a parathyroid cyst: report of a case. *Surg Today* 2003;33:354–7.
- [157] Glynn N, Cunningham J, Tormey W, et al. Multiple functional parathyroid cysts. *J Clin Endocrinol Metab* 2013;98:2641–2.
- [158] Kalager T, Glück E, Heimann P, et al. Phaeochromocytoma with ectopic calcitonin production and parathyroid cyst. *Br Med J* 1977;2:21.
- [159] Tamiya H, Miyakawa M, Suzuki H, et al. A large functioning parathyroid cyst in a patient with multiple endocrine neoplasia type 1. *Endocr J* 2013;60:709–14.
- [160] Colindres LE, Rodríguez MA, Casado IG, et al. Quiste paratiroides: diagnóstico diferencial de tumoración cervical. *An Pediatr* 2003;58:188–90.
- [161] Entwistle J, Pierce C, Johnson D, et al. Parathyroid cysts: report of the sixth and youngest pediatric case. *J Pediatr Surg* 1994;29:1528–9.
- [162] Cooper KJ, Hill ADK, Sangwan Y, et al. Hypercalcemia associated with a parathyroid cyst. *Ulster Med J* 1994;63:246–7.
- [163] Lydiatt W, Shaha A, Munshi I, et al. Giant mediastinal masquerading as parathyroid a substernal cyst goiter. *Otolaryngol Head Neck Surg* 1997;116:411–3.
- [164] Abate EG, Bernet V, May GR, et al. An uncommon cause of asymptomatic primary hyperparathyroidism. *J Clin Endocrinol Metab* 2012;97:4304–5.
- [165] Hauet E, Paul M, Salu M. Compression of the trachea by a mediastinal parathyroid cyst. *Ann Thorac Surg* 1997;64:851–2.
- [166] Kaplanoglu V, Kaplanoglu H, Ciliz D, et al. A rare cystic lesion of the neck: parathyroid cyst. *BMJ Case Rep* 2013;2013:pii: bcr2013200813.
- [167] Kato H, Kanematsu M, Kiryu T, et al. Nonfunctional mediastinal parathyroid cyst: imaging findings in two cases. *Clin Imaging* 2008;32:310–3.
- [168] Cappelli C, Gandossi E, Pirola I, et al. Parathyroid cyst: often mistaken for a thyroid cyst. *World J Surg* 2007;31:2269.
- [169] Røjdmark J, Monchik J. Concentrations of parathyroid hormone in functioning and non-functioning parathyroid cysts. *Eur J Surg* 1998;164:65–7.
- [170] Sanchez A, Carretto H. Treatment of a nonfunctioning parathyroid cyst with tetracycline injection. *Head Neck* 1993;15:263–5.
- [171] Piccinato CE, Cherri J, Llorach-Velludo MA, et al. [Nonfunctioning parathyroid cyst simulating thyroid nodule] [Article in Portuguese]. *Rev Paul Med* 1990;180:236–8.
- [172] Nardi CEM, da Silva R, Serafim C, et al. Nonfunctional parathyroid cyst: case report. *Sao Paulo Med J* 2009;127:382–4.
- [173] Ujiki M, Sturgeon C, Nayar R, et al. Parathyroid cyst: often mistaken for a thyroid cyst. *World J Surg* 2008;32:1234.
- [174] Stoffer S, Szpunar W, Hawker CD. Differentiation of thyroid from parathyroid cysts. *JAMA* 1980;243:1422.
- [175] Ginsberg J, Young J, Walfish P. Parathyroid cysts. *JAMA* 1978;240:1506–7.
- [176] Wakabayashi K, Takahashi T, Tejima S. [Parathyroid cyst] [Article in Japanese]. *Nihon Rinsho* 1995;53:1004–7.
- [177] Pacini F, Antonelli A, Lari R, et al. Unsuspected parathyroid cysts diagnosed by measurement of thyroglobulin and parathyroid hormone concentrations in fluid aspirates. *Ann Intern Med* 1985;102:793–4.
- [178] Birnbaum J, Van Herle AJ. Immunoheterogeneity of parathyroid hormone in parathyroid cysts: diagnostic implications. *J Endocrinol Invest* 1989;12:831–6.
- [179] Oldham HNJ. Mediastinal tumors and cysts: collective review. *Ann Thorac Surg* 1971;11:246–75.
- [180] Spitz A. Management of a functioning mediastinal parathyroid cyst. *J Clin Endocrinol Metab* 1995;80:2866–8.
- [181] Stavrou GA, Jahns R, Flemming P, et al. [Hormone inactive parathyroid cyst: rare differential diagnosis in the evaluation of cervical cysts] [Article in German]. *Zentralbl Chir* 2007;132:161–4.
- [182] Ferrara BE, Hazell S, Parker TH, et al. Parathyroid cyst. *South Med J* 1985;78:528–32.
- [183] Wang CA, Vickery AL, Maloot F. Large parathyroid cysts mimicking thyroid nodules. *Ann Surg* 1972;175:448–53.
- [184] Paseyro de Morelli AM, Iraola ML, Maggiolo J. Cytological study of parathyroid cysts: based on 27 observations. *Rev Arg Endocrinol Metab* 1987;24:96–8.
- [185] Siström C, Hanks J, Feldman P. Supraclavicular mass in a woman with hyperparathyroidism. *Invest Radiol* 1994;29:244–7.
- [186] Krudy AG, Doppman JL, Shawker TH, et al. Hyperfunctioning cystic parathyroid glands: CT and sonographic findings. *AJR Am J Roentgenol* 1984;142:175–8.
- [187] Mevio E, Gorini E, Sbrocca M, et al. Parathyroid cysts: description of two cases and review of the literature. *Acta Otorhinolaryngol Ital* 2004;24:161–4.
- [188] Hockstein N, Dyce O, Ross A, et al. A parathyroid cyst with mediastinal extension: report of a case. *Otolaryngol Head Neck Surg* 2002;126:578–80.
- [189] Chaffanjon PCJ, Cardin N, Chabre O, et al. Parathyroid cysts. *Ann Chir* 2001;126:456–8.
- [190] Codreanu C. Parathyroid cysts, a rare condition: case report. *Acta Endocrinol (Bucharest)* 2009;5:411–5.
- [191] Ramos-Gabatin A, Young RL, Schenk D. Parathyroid cyst: medical diagnosis and therapy. *South Med J* 1982;75:1138–9.
- [192] Polovina S, Andjelkovic Z, Micic D. Non-functional parathyroid cyst - diagnostic pitfall: a case-report. *Vojnosanit Pregl* 2015;72:1032–4.
- [193] Suzuki K, Sakuta A, Aoki C, et al. Hyperparathyroidism caused by a functional parathyroid cyst. *BMJ Case Rep* 2013;2013:pii: bcr2012008290.
- [194] Béquignon A, Babin E, Moreau S, et al. [Parathyroid cysts] [Article in French]. *Ann Otolaryngol Chir Cervicofac* 2001;118:378–81.
- [195] Fortson J, Patel V, Henderson V. Parathyroid cysts: a case report and review of the literature. *Laryngoscope* 2001;111:1726–8.
- [196] Uwents P, Debruyne F, Delaere P, et al. Le kyste parathyroïdien, une cause de tumefaction dans la région du cou [Parathyroid cyst, aetiology of anterior lower neck mass]. *Rev Laryngol Otol Rhinol (Bord)* 1994;115:113–5.

- [197] Perdue GD, Martin ID. Parathyroid cyst: report of a case. *Am Surg* 1952;25:698-701.
- [198] Ippolito G, Palazzo FF, Sebag F, et al. A single-institution 25-year review of true parathyroid cysts. *Langenbecks Arch Surg* 2006;391:13-8.
- [199] Ihm P, Dray T, Sofferan RA, et al. Parathyroid cysts: diagnosis and management. *Laryngoscope* 2001;111:1576-8.
- [200] Ghervan C, Goel P. Parathyroid cyst, a rare cause of cystic cervical lesion. *Case report. Med Ultrason* 2011;13:157-60.
- [201] Kuo YJ, Okada Y, Kawamura J, et al. Parathyroid cysts with primary hyperparathyroidism: report of a case. *Hinyokika Kyo* 1983;29:1531-5.
- [202] Katsumi T, Murayama K, Tada A, et al. [Two cases of hyperfunctioning parathyroid cyst] [Article in Japanese]. *Hinyokika Kyo* 1986;32:1026-9.
- [203] Wright JG, Brangle RW. Carcinoma in a parathyroid cyst. *IMJ Ill Med J* 1985;168:98-100.
- [204] Marti J, Martin Arregi FJ, Mutio L, et al. Quiste Paratiroideo. A Proposito de un caso [Parathyroid cyst. Report of one case]. *Acta Otorrinolaringol Esp* 2002;53:302-4.
- [205] Oertel Y, Wargotz E. Diagnosis of parathyroid cysts. *Am J Clin Pathol* 1987;88:252-3.
- [206] Nozeran S, Duquenne M, Guyetant S, et al. [Diagnosis of parathyroid cysts: value of parathyroid hormone level in puncture fluid] [Article in French]. *Presse Med* 2000;29:939-41.
- [207] Lee SL. Parathyroid cyst fluid: discrepancy between C-terminal and intact parathyroid hormone assays. *Thyroid* 2000;10:1125-6.
- [208] Makino T, Sugimoto T, Kaji H, et al. Functional giant parathyroid cyst with high concentration of CA19-9 in cystic fluid. *Endocr J* 2003;50:215-9.
- [209] Kassaras G, Nissotakis C, Spiridakis J, et al. Parathyroid gland cyst. *Am Surg* 2010;76:e11-2.
- [210] Lassaletta L, Bernaldez R, Garcia-Pallares M, et al. Surgical management of recurrent parathyroid cyst. *Auris Nasus Larynx* 2002;29:83-5.
- [211] Varaldo E, Minuto M, Torre G. Parathyroid cyst: a case report and review of the literature. *Ann Ital Chir* 2001;73:343-5.
- [212] Zingrillo M, Ghiggi MR, Liuzzi A. A large, nonfunctioning parathyroid cyst recurring after aspiration and subsequently cured by percutaneous ethanol injection. *J Clin Ultrasound* 1996;24:378-82.
- [213] Cavallaro A, De Toma G, Cavallaro G, et al. Le cisti paratiroidee: considerazioni a proposito di un caso [Parathyroid cysts: comments apropos a case]. *Ann Ital Chir* 1999;70:575-81.
- [214] Shi B, Guo H, Tang N. Treatment of parathyroid cysts with fine-needle aspiration. *Ann Intern Med* 1999;131:797-8.
- [215] Kodama T, Obara T, Fujimoto Y, et al. Eleven cases of nonfunctioning parathyroid cyst: significance of needle aspiration in diagnosis and management. *Endocrinol Jpn* 1987;34:769-77.
- [216] Okamura K, Hioroshi I, Sato K, et al. Sclerotherapy for benign parathyroid cysts. *Am J Surg* 1992;163:344-5.
- [217] Akel M, Salti I, Azar ST. Successful treatment of parathyroid cyst using ethanol sclerotherapy. *Am J Med Sci* 1999;317:50-2.
- [218] Garcia Pascual L. Sclerosis with ethanol of a non-functioning parathyroid cyst. *Endocrinol Nutr* 2003;50:81-3.
- [219] Sung JY, Baek JH, Kim KS, et al. Symptomatic nonfunctioning parathyroid cysts: role of simple aspiration and ethanol ablation. *Eur J Radiol* 2013;82:316-20.
- [220] Pontikides N, Karras S, Kaprara A, et al. Diagnostic and therapeutic review of cystic parathyroid lesions. *Hormones* 2013;11:410-8.
- [221] Mikami I, Koizumi K, Shimizu K, et al. Functional mediastinal parathyroid cyst: report of a case. *Surg Today* 2002;32:351-3.
- [222] Yang Z, Chen XH, Fang JG, et al. [Clinical analysis on nonfunctioning parathyroid cysts: a report of six cases]. *Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi* 2012;47:417-9.
- [223] Hamy A, Masson S, Heymann MF, et al. Parathyroid cysts; Ten cases. *Ann Chir* 2002;127:203-7.
- [224] Lorenzo J, Fernandez G, Iglesias B, et al. Recurrent parathyroid cyst; one case. *An Med Interna* 2008;25:231-3.