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ORIGINAL PAPER

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The comorbidity of papillary thyroid carcinoma and the primary hyperparathyroidism

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ABSTRACT

Introduction. The prevalence of papillary thyroid carcinoma (PTC) in patients with primary hyperparathyroidism (PHPT) is low, it can be estimated around 2 to 4%. For unknown reasons it is higher than the prevalence of PTC in the overall population. The authors analyse the comorbidity of PTC with PHPT on patients treated in their institution.

Material and method. The analysis covered medical records of 885 patients subject to the thyroid resection procedure and 95 patients operated for PHPT, the procedures were performed in years 2005-2014.

Results. In the above-mentioned period there were 121 patients operated due to a malignant thyroid tumour and there were 95 patients that had surgery for PHPT. There were 4 cases of comorbidity of PHPT with papillary thyroid cancer.
Prevalence of PTC at the patients with PHPT was 4.2%.
In two out of the four cases, both diseases were diagnosed prior to the procedure and the single appropriate surgery i.e. total thyroidectomy and excision of parathyroid adenoma was performed.
In the other two cases false positive localisation of parathyroid adenoma occurred due to metastatic cancerous lesions in cervical lymph nodes. The diagnosis of PTC was made postoperatively based on surgical specimen examination. Second surgical procedure appropriate for this diagnosis was necessary in both cases.

Conclusions. The comorbidity of PHPT and PTC is clinically important and should be taken into account in the case of patients with PHPT and thyroid tumours. There is the possibility of false positive localization of parathyroid adenoma in the case of metastatic cancerous lesions in cervical lymph nodes.

Keywords. thyroid carcinoma, primary hyperparathyroidism, parathyroid adenoma

Introduction

Primary hyperparthyroidism (PHPT) affects around 0.1-0.5% of population and the clinical symptoms of it are: hypercalcemia, often urolithiasis and osteopenia.[1] It may occur as a part of Multiple Endocrine Neoplasia syndromes.

According to the Polish National Cancer Registry, thyroid neoplasms are 0.5% of neoplasm cases in men

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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and 2.6% in women. They occur predominantly for people in their thirties and fifties, more often in women than men. Papillary thyroid cancer (PTC) and follicular thyroid cancer are 90-95% of all cases of thyroid cancer.

The comorbidity of PHPT and thyroid diseases is frequent and occurs in 20-60% of cases.[2–5] The comorbidity of thyroid and parathyroid diseases was described for the first time in 1947 and it concerned a case of comorbidity of hypothyroidism and hyperparathyroidism.[6]

In the genetic Multiple Endocrine Neoplasia-2A syndrome (also known as Sipple's syndrome), the medullary thyroid cancer and PHPT often co-occur.[7] On the contrary, the comorbidity of PHPT and PTC is rare (2-4%), but it is more frequent than in general population.[8-25] The reasons for higher prevalence of PTC in patients with PHPT are yet to be discovered.[24]

Aim of the study

The purpose of the paper is to assess the comorbidity of PTC and PHPT in patients treated in the authors institution.

Material and method

Based on the computer database containing the medical records of Clinical Hospital No. 2 in Rzeszow, we identified all patients admitted since January 2005 to April 2014 who had the thyroid resection procedure and/or patients subject to surgical treatment for PHPT at the Department of General Surgery

In this period, there were 885 thyroid procedures performed. In 341 cases, it was the complete removal of the thyroid; in 314 cases, it was the removal of a thyroid lobe and isthmus; in 217 cases, it was the subtotal removal of the thyroid; and in 13 cases, it was the partial removal of the thyroid (Fig. 1). All patients operated due to thyroid malignancy were identified and compared with the list of patients operated for PHPT.

In all patients with the thyroid pathology, the neck ultrasonography (USG), Fine Needle Aspiration Biopsy (FNAB) of the thyroid tumours suspected for malignancy, laryngological examination as well as levels of FT3, FT4, TSH in blood serum were performed. In the case of PHPT, the levels of parathormone, calcium and phosphates in blood serum were routinely checked; the neck scintigraphy 99m Technetium-sestamibi ('sestamibi') dual-phase and USG neck scan were performed.

Results

There were 121 patients operated due to a malignant thyroid tumour, which is 13.7% of all thyroid resections performed.

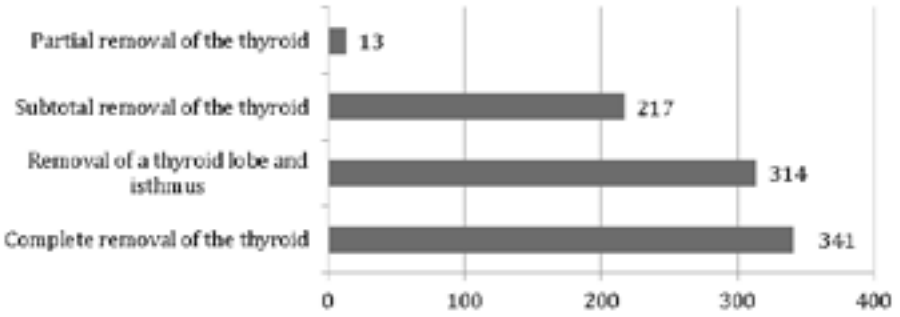

Fig. 1. Thyroid resection procedures performed from Jan 2005 to Apr 2014

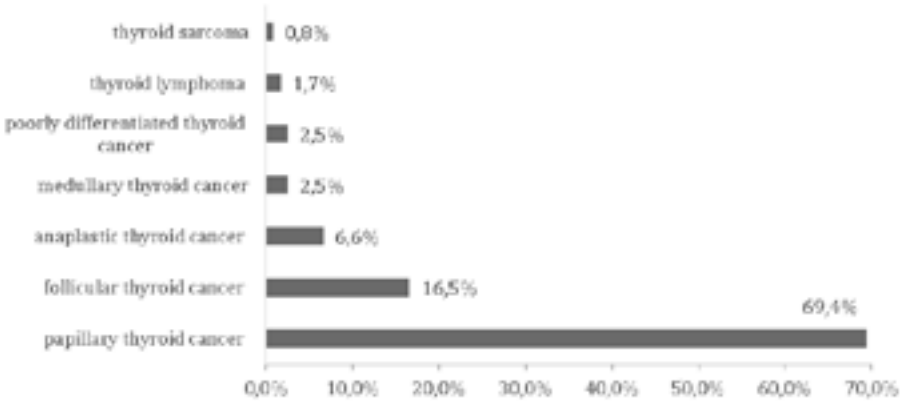

Fig. 2. Thyroid carcinomas identified during the histopathological examination after thyroid resection procedures from Jan 2005 to Apr. 2014

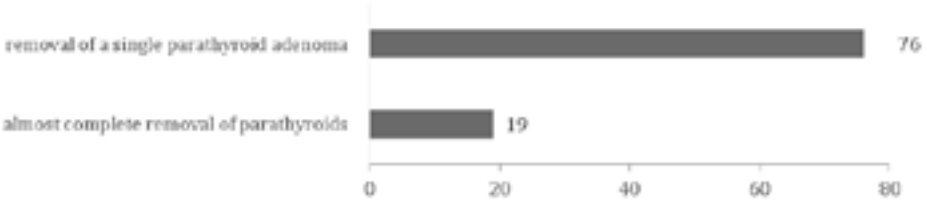

Fig. 3. Parathyroid resection procedures performed from Jan 2005 to Apr 2014

There were 84 patients operated due to PTC (69,4%), 20 patients operated due to follicular thyroid cancer (16.5%), 8 patients operated due to anaplastic thyroid cancer (6.6%); 3 patients due to medullary thyroid cancer (2.5 %), 3 due to poorly differentiated thyroid cancer (2.5 %), 2 due to thyroid lymphoma (1.7%), 1 due to sarcoma (0.8%) (Fig. 2).

In the studied period, 95 procedures of parathyroid resection were performed.In 19 cases, it was almost complete removal of parathyroid glands (20%), and in 76 cases it was the removal of a single parathyroid adenoma (80%) (Fig. 3).

Gender and age of patients with PHPT and PTC is presented in Tab. 1.

In four patients, the comorbidity of PTC and PHPT was determined, which is 4.2% of PTC cases in patients operated due to the PHPT. All four patients have diagnosis of primary hyperparathyroidism based on metabolic evaluation and elevated serum parathormone level.

Table 1. Gender and age of patients with PHPT and PTC

	women	men	womens age	mens age
PTC	69	15	18-87 avg 53	20-76 avg 48
PHPT	75	20	20-84 avg 60	22-75 avg 55

The diagnosis of PTC before surgery was made only in two out of four patients (50%) by FNAB. The other two patients had diagnosis of PTC based on surgical specimen microscopic examination after first surgery.

Parathyroid adenomas localization by ^{99m}Tc-MIBI dual-phase planar imaging was correct in one patient out of four patients. In the next case there were no gathering of marker outside thyroid gland and in two other cases scintigraphy showed metastatic lymph nodes while adenomas were not localised.

Clinical and surgical details of patients with the comorbidity of PTC and PHPT are summarised in Tab. 2, 3, 4.

Table 2. Diagnostic workup of cases with the comorbidity of PTC and PHPT

	gender	age	PTH serum level	Calcium serum level	Diagnosis before surgery
Case 1	W	62	239.8 pg/ml (std. 15-65pg/ml)	elevated	PHPT- adenomas of right parathyroids, Right lobe thyroid tumor
Case 2	M	71	elevated	elevated	PHPT – adenoma of right lower parathyroid, nodular goiter
Case 3	W	66	elevated	elevated	PHPT- adenoma of left lower parathyroid, PTC
Case 4	W	27	130.5 pg/ml (std. 15-65pg/ml)	12.2 mg/dl (std. 8.8-10.6 mg/dl)	PHPT, left lobe PTC

Table 3. Imagining examinations and FNAB of cases with the comorbidity of PTC and PHPT

	FNAB of thyroid tumor	USG scan of the neck	CT of the neck	Scintigraphy of the neck
Case 1	benign lesion	Right thyroid lobe tumor, two tumors outside the right thyroid lobe	Right thyroid lobe tumor, two tumors outside the right thyroid lobe	Intensified gathering of marker in lesions outside thyroid
Case 2	benign lesion	Nodular goiter, Right lower parathyroid adenoma	none	Right lower parathyroid adenoma
Case 3	PTC	Nodular goiter, lesion suspected for malignancy in isthmus	none	Left lower parathyroid adenoma
Case 4	PTC	Nodular goiter, lesion suspected for malignancy in left lobe	none	No localization of parathyroid adenoma

Table 4. Surgical treatment of cases with the comorbidity of PTC and PHPT

	First surgical procedure	Specimen microscopic examination	Second surgical procedure	Results
Case 1	Right thyroid lobectomy Removal of two tumors located near right thyroid lobe	Right lobe PTC with metastases to lymph nodes	Completion thyroidectomy, right cervical lateral lymphadenectomy, left lower parathyroid adenoma removal	Supplemented treatment with radioiodine, Euthyroidism on levothyroxine, normal function of parathyroids
Case 2	Removal of enlarged lymph node below lower pole of right thyroid lobe, Excision of parathyroid adenoma in mediastinum	PTC metastasis to lymph node, parathyroid adenoma in mediastinum	Total strumectomy, no primary PTC focus in thyroid	Suplemented treatment with radioiodine, Euthyroidism on levothyroxine, normal function of parathyroids
Case 3	Total strumectomy, paratracheal lymhadenectomy, excision of left lower parathyroid adenoma	Bifocal PTC of the thyroid, left lower parathyroid hyperplasia, No metastases to lymph nodes	none	Euthyroidism on levothyroxine, normal function of parathyroids
Case 4	Total strumectomy, paratracheal lymhadenectomy, excision of right upper parathyroid adenoma	Left lobe PTC, no metastases to lymph nodes, right upper parathyroid adenoma	none	Euthyroidism on levothyroxine, Planned Supplemented treatment with radioiodine, hypoparathyroidism

Discussion

The incidence of PTC in patients with PHPT is rare. It is higher than the incidence of PTC in general population. It can be estimated as 2-4%.[11,21–23] In our series it was 4.2% and was comparable to the results described in the literature. It does not differ from the incidence of PTC at patients operated due to the nodular goitre.[21,25] So far, it has not been determined whether a factor causing the higher incidence of PTC at patients operated due to PHPT exists.[11]

Due to the high prevalence of the thyroid gland pathology in patients treated surgically for PHPT, estimated around 20-60%[2–5], it is advisable to perform standard preoperative USG scan of the neck with a possible fine needle biopsy of the focal thyroid lesions and/or lymph nodes suspected for malignancy.[4,26]

In our material, the cervical USG scan and 99m Technetium-sestamibi dual-phase scintigraphy of the neck were routinely performed at patients qualified for the surgical treatment due to PHPT, which are currently standard techniques of parathyroid imaging.[27–30]

Despite performing these tests, the thyroid cancer was diagnosed before surgery in only two out of four cases with comorbidity of PHPT and PTC. This indicates difficulties in differentiation of malignant tumors and parathyroid adenomas using the above methods.

Similar diagnostic problems using sestamibi dual-phase scintigraphy and USG of the neck descibed K.L.Whitcroft. False identification of thyroid PTC as parathyroid adenoma resulted in surgical bilateral neck exploration to find real localisation of parathyroid adenoma, and second surgery for completion thyroidectomy due to PTC, which was unsuccessful due to extensive postoperative fibrosis.[31]

Diagnostic problems in patients who had coincidence of thyroid and parathyroid pathology showed by Onkendi et al in their retrospective analysis of scintigraphy used in 374 patients. A false-positive rate of parathyroid localization in 22% of patients with benign thyroid disease and 45% with malignant thyroid disease was reported.[32]

Inadequate diagnosis before surgery makes two problems. First, inappropriate localization of parathyroid adenoma can cause failure of PHPT treatment. Second, misinterpretation of scintigraphy can result in lack of diagnosis of PTC before surgery. Both problems can lead to second surgery with increased risk of complications such as recurrent laryngeal nerve palsy or postoperative parathyroid insufficiency. Increased risk is caused by inflammation and/or fibrosis after original operation.

In our series, one adequate surgery for both diseases was performed in patients with correct diagnosis made before surgery.

The next two cases were misdiagnosed, metastatic lymph nodes were wrongly identified as parathyroid adenomas. Correct diagnosis was based on postoperative surgical specimen examination which revealed metastasis of PTC to the lymph nodes removed.

Both cases were scheduled to total thyroidectomy, and second surgery was performed uneventfully. In one

of the patients removal of earlier missed parathyroid adenoma was also performed

Similar cases was described by Lee JK and co-authors[33] and by Polyzos SA et al.[34] The thyroid cancer was diagnosed based on examination of the metastatic lymph node removed along with the parathyroid adenoma; in the thyroid removed during second surgery the focus or foci of papillary thyroid cancer was found.

In our patients with second surgery performed, there were two foci of PTC in one patient and no focus of PTC in the second.

The last patient may be similar to cases described by Yamamoto T and co-authors.[35] They reported the metastases of PTC in 3 out of 148 patients subject to the cervical lymphadenectomy due to squamous cell cancer of the oral cavity. The patients were subjected to observation, and the progression of thyroid cancer was not found in 3-5 years.

The detection of parathyroid adenomas by ^{99m}Tc-MIBI dual-phase planar imaging in our series was correct in one patient out of four. In the next case no gathering of marker outside thyroid gland occurred and in two other cases scintigraphy showed metastatic lymph nodes and adenomas were not found.

To improve the accuracy of preoperative diagnosis in primary hyperparathyroidism, secondary hyperparathyroidism, thyroid lesions or metastatic lymph nodes newer diagnostic methods like ^{18}F-fluorocholine hybrid positron emission tomography/X-ray computed tomography (FCH-PET/CT) or ^{99m}Tc-MIBI single-photon emission computed tomography associated with computed tomography scintigraphy (^{99m}Tc-MIBI SPECT/CT) were proposed.

FCH-PET/CT detects a significantly greater number of abnormal parathyroid glands than USG and it is at least as sensitive as ^{123}I/^{99m}Tc-sestaMIBI dual-phase scintigraphy without reducing specificity.[36]

^{99m}Tc-MIBI SPECT/CT has significantly higher sensitivity in the detection of PHPT lesions than does ^{99m}Tc-MIBI dual-phase planar imaging (87.8% *vs.* 75.6%, $P < 0.05$) and it also can detect a greater number of other abnormal lesions, particularly hyperplastic lesions.[37]

On the other hand Nagar and coauthors recommend a novel interpretation techniqe of SESTAMIBI SCANS combined with USG of the neck to increase the detection of parathyroid adenomas. Additional lenght of the thyroid lobe on sestamibi compared to the lobe lenght on USG was considered a positive finding. They increased sensitivity of adenoma detection to 93.8% in comparison to the traditional SESTAMIBI image (68-87%).[38]

Conclusions

PHPT and PTC occur together rarely with the prevalence of 2-4%. Diagnosis of the comorbidity of both diseases makes possible treatment during one surgery. Thus, such a comorbidity should be considered in patients with PHPT and focal thyroid lesions. Despite performing imaging tests like cervical USG and SESTAMIBI SCANS on routine basis, a correct diagnosis before surgery may not be easy. Metastatic cervical lymph node may be wrongly assumed as parathyroid adenoma.

References

1. Bilezikian JP, Silverberg SJ. Asymptomatic primary hyperparathyroidism. *N Engl J Med*. 2004;350(17):1746-1751. doi:10.1056/NEJMcp032200
2. Friedrich J, Krause U, Olbricht T, Eigler FW. Simultaneous interventions of the thyroid gland in primary hyperparathyroidism (pHPT). *Zentralbl Chir*. 1995;120(1):43-46.
3. Adler JT, Chen H, Schaefer S, Sippel RS. Does Routine Use of Ultrasound Result in Additional Thyroid Procedures in Patients with Primary Hyperparathyroidism? *J Am Coll Surg*. 2010;211(4):536-539. doi:10.1016/j.jamcollsurg.2010.05.015
4. Regal M, Paramo C, Luna Cano R, et al. Coexistence of primary hyperparathyroidism and thyroid disease. *J Endocrinol Invest.* 1999;22(3):191-197.
5. Attie JN, Vardhan R. Association of hyperparathyroidism with nonmedullary thyroid carcinoma: review of 31 cases. *Head Neck.* 1993;15(1):20-23.
6. Kissin M, Bakst H. Co-existing myxedema and hyperparathyroidism: case report. *J Clin Endocrinol.* 1947;7(2):152-158. doi:10.1210/jcem-7-2-152
7. Beus KS, Stack BC. Synchronous thyroid pathology in patients presenting with primary hyperparathyroidism. *Am J Otolaryngol.* 2004;25(5):308-312.
8. Vysetti S, Sridhar P, Theckedath B, Gilden JL, Morawiecki P. Synchronous Papillary Thyroid Carcinoma and Primary Hyperparathyroidism: Diagnosis and Management Issues. *Hosp Pract*. 2012;40(4):16-19. doi:10.3810/hp.2012.10.998
9. Kwee HWS, Marapin V, Verkeyn JMA, van Nederveen FH. A man with thyroid abnormalities: ectopic parathyroid adenoma and multifocal thyroid carcinoma. *Ned Tijdschr Geneeskd*. 2012;156(41):A5146.
10. Javadi H, Jallalat S, Farrokhi S, et al. Concurrent papillary thyroid cancer and parathyroid adenoma as a rare condition: a case report. *Nucl Med Rev Cent East Eur.* 2012;15(2):153-155.
11. Mahmoodzadeh H, Harirchi I, Hassan Esfehani M, Alibakhshi A. Papillary thyroid carcinoma associated with parathyroid adenoma. *Acta Med Iran*. 2012;50(5):353-354.
12. Ghorra C, Rizk H, Abi Hachem R, Tannoury J, Abboud B. Association of parathyroid pathology with well-differentiated thyroid carcinoma. *Presse Med*. 2012;41(6):e265--e271. doi:10.1016/J.LPM.2011.12.016
13. Baumann K, Weichert J, Krokowski M, Diedrich K, Banz--Jansen C. Coexistent parathyroid adenoma and thyroid papillary carcinoma in pregnancy. *Arch Gynecol Obstet*. 2011;284(1):91-94. doi:10.1007/s00404-011-1903-0

14. Rajewska J, Lacka K, Stawny B, Majewski P. Primary hyperparathyroidism in patient with thyroid papillary cancer--case report. *Pol Merkur Lekarski.* 2010;29(174):373-376.
15. Chaychi L, Belbruno K, Golding A, Memoli V. Unusual Manifestation of Parathyroid Carcinoma in the Setting of Papillary Thyroid Cancer. *Endocr Pract.* 2010;16(4):664-668. doi:10.4158/EP10061.CR
16. Alavi MS, Azarpira N, Mojallal M. Incidental finding of bilateral papillary thyroid carcinoma in a patient with primary hyperparathyroidism. *Hell J Nucl Med.* 2010;13(1):56-58.
17. Iakovou IP, Konstantinidis IE, Chrisoulidou AI, Doumas AS. Synchronous parathyroid adenoma and thyroid papillary carcinoma: a case report. *Cases J.* 2009;2(1):9121. doi:10.1186/1757-1626-2-9121
18. Turki ZM, Hajri H, Zrig N, Kourda N, Ferjaoui M, Ben Slama C. Toxic nodular goitre associated with papillary thyroid carcinoma and primary hyperparathyroidism. R*ev Laryngol Otol Rhinol (Bord).* 2006;127(4):239-242.
19. Meshikhes A-WN, Butt SA, Al-Saihati BA. Combined parathyroid adenoma and an occult papillary carcinoma. *Saudi Med J.* 2004;25(11):1707-1710.
20. Krause U, Benker G, Reiners C, Rudy T. Coincidence of hyperparathyroidism and thyroid gland cancer. *Langenbecks Arch Chir Suppl II Verh Dtsch Ges Chir.* 1990:983-985.
21. De Menezes Montenegro FL, Lourenço DM, Tavares MR, et al. Total parathyroidectomy in a large cohort of cases with hyperparathyroidism associated with multiple endocrine neoplasia type 1: experience from a single academic center. *Clinics*. 2012;67(1):131-139. doi:10.6061/clinics/2012(Sup01)22.
22. Leitha T, Staudenherz A. Concomitant Hyperparathyroidism and Nonmedullary Thyroid Cancer, with a Review of the Literature. *Clin Nucl Med.* 2003;28(2):113-117. doi:10.1097/01.RLU.0000048680.30820.52
23. Krause UC, Friedrich JH, Olbricht T, Metz K. Association of primary hyperparathyroidism and non-medullary thyroid cancer. *Eur J Surg.* 1996;162(9):685-689.
24. Lehwald N, Cupisti K, Krausch M, Ahrazoglu M, Raffel A, Knoefel WT. Coincidence of Primary Hyperparathyroidism and Nonmedullary Thyroid Carcinoma. *Horm Metab Res.* 2013;45(09):660-663. doi:10.1055/s-0033-1345184
25. Fedorak IJ, Salti G, Fulton N, Schark C, Straus FH 2nd, Kaplan EL. Increased incidence of thyroid cancer in patients with primary hyperparathyroidism: a continuing dilemma. *Am Surg*. 1994;60(6):427-431.
26. Masatsugu T, Yamashita H, Noguchi S, et al. Thyroid evaluation in patients with primary hyperparathyroidism. *Endocr J.* 2005;52(2):177-182.
27. Lachungpa T, Sarawagi R, Chakkalakkoombil SV, Jayamohan AE. Imaging features of primary hyperparathyroidism. *BMJ Case Rep*. 2014;2014. doi:10.1136/bcr-2013-203521
28. Weiss DM, Chen H. Role of cervical ultrasound in detecting thyroid pathology in primary hyperparathyroidism. *J Surg Res*. 2014;190(2):575-578. doi:10.1016/j.jss.2014.03.038
29. Greilsamer T, Blanchard C, Christou N, et al. Management of thyroid nodules incidentally discovered on MIBI scanning for primary hyperparathyroidism. *Langenbeck's Arch Surg.* 2015;400(3):313-318. doi:10.1007/s00423-015-1286-y
30. Arciero CA, Shiue ZS, Gates JD, et al. Preoperative Thyroid Ultrasound Is Indicated in Patients Undergoing Parathyroidectomy for Primary Hyperparathyroidism. *J Cancer.* 2012;3:1-6.
31. Whitcroft KL, Sharma A. Sestamibi scintigraphy for parathyroid localisation: a reminder of the dangers of false positives. *BMJ Case Reports*. 2014;2014. doi:10.1136/bcr-2013-203225
32. Onkendi EO, Richards ML, Thompson GB, Farley DR, Peller PJ, Grant CS. Thyroid Cancer Detection with Dual-isotope Parathyroid Scintigraphy in Primary Hyperparathyroidism. *Ann Surg Oncol*. 2012;19(5):1446-1452. doi:10.1245/s10434-012-2282-x
33. Lee J, Obrzut S, Yi E, Deftos L, Bouvet M. Incidental Finding of Metastatic Papillary Thyroid Carcinoma in a Patient with Primary Hyperparathyroidism. *Endocr Pract*. 2007;13(4):380-383. doi:10.4158/EP.13.4.380
34. Polyzos SA, Anastasilakis AD, Iakovou IP, Partsalidou V. Primary hyperparathyroidism and incidental multifocal metastatic papillary thyroid carcinoma in a man. *Arq Bras Endocrinol Metabol*. 2010;54(6):578-582.
35. Yamamoto T, Tatemoto Y, Hibi Y, Ohno A, Osaki T. Thyroid Carcinomas Found Incidentally in the Cervical Lymph Nodes: Do They Arise From Heterotopic Thyroid Tissues? *J Oral Maxillofac Surg*. 2008;66(12):2566-2576. doi:10.1016/J.JOMS.2008.06.025
36. Michaud L, Balogova S, Burgess A, et al. A Pilot Comparison of 18F-fluorocholine PET/CT, Ultrasonography and 123I/99mTc-sestaMIBI Dual-Phase Dual-Isotope Scintigraphy in the Preoperative Localization of Hyperfunctioning Parathyroid Glands in Primary or Secondary Hyperparathyroidism: Influence of. *Medicine (Baltimore).* 2015;94(41):e1701.
37. Li Q, Pan J, Luo Q, Wang Y, Bao Y, Jia W. The key role of 99mTc-MIBI SPECT/CT in the diagnosis of parathyroid adenoma: a case report. *Arch Endocrinol Metab.* 2015;59:265-269.
38. Nagar S, Walker DD, Embia O, Kaplan EL, Grogan RH, Angelos P. A novel technique to improve the diagnostic yield of negative sestamibi scans. *Surgery.* 2014;156(3):584-590. doi:10.1016/j.surg.2014.05.020