

Perioperative calcium and vitamin D supplementation in patients undergoing thyroidectomy – literature review

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Article history: Received: 13.09.2017 Accepted: 08.06.2018 Published: 31.08.2018

ABSTRACT:

Introduction: Postoperative hypocalcemia is a narrow but significant problem for patients undergoing thyroid and parathyroid surgery. It is the most common complication after thyroidectomy. It is associated with transient or permanent hypoparathyroidism. It could potentially be life-threatening for patients and increases the costs of hospitalization. The aim of the study was to evaluate the results of studies that routinely administered calcium and/or vitamin D during the postoperative period.

Materials and Methods: In this article, a literature review – 15 studies that used routine perioperative calcium (7 studies), vitamin D (2 studies) and calcium with vitamin D (11 studies) supplementation was performed. Supplementation effectiveness in prevention of postoperative hypocalcemia was compared to no prophylaxis in 10 studies. Five studies compared the effect of combined administration (calcium and vitamin D) to calcium alone. The number of papers dealing with this problem is not particularly high.

Results: Supplementation significantly decreased the rate of laboratory and symptomatic hypocalcemia. It was also effective in reducing the severity of symptoms. The combination of calcium with vitamin D was the most effective strategy. No hypercalcemia or parathyroid hormone inhibition was observed in the supplemented groups. Routine supplementation was less expensive than performing laboratory tests in the course of treatment of hypocalcemia.

Conclusions: The results of analyzed studies showed the clinical and economic advantage of routine perioperative prophylactic supplementation of vitamin D and/or calcium as compared to no prophylaxis. However, the majority of studies showed a significant range of variability in patients' characteristics. Numerous studies did not evaluate the preoperative 25-hydroxycholecalciferol level – a risk factor for postoperative hypocalcemia.

Discussion: The use of routine prophylactic supplementation of calcium and vitamin D in the perioperative period can be useful in everyday clinical practice. Further research is needed to draw clear guidelines regarding prophylactic calcium and vitamin D therapy for patients after thyroidectomy.

KEYWORDS:

hypocalcemia, hypoparathyroidism, calcium, vitamin D, thyroidectomy, perioperative period

Due to the health and economic consequences of postoperative hypocalcemia, it is necessary to disseminate knowledge about non-invasive methods of limiting it that can be used in everyday clinical practice such as routine perioperative calcium and vitamin D supplementation.

Thyroidectomy is one of the most commonly performed procedures in endocrine surgery in Poland – over 20 000 per year (according to Polish National Health Fund). The risk of the following complications is connected with this procedure: bleeding, laryngeal nerve damage and above all – most common – hypoparathyroidism (HP). Postoperative hypocalcemia (PH) occurs in 1.6–54% of operated patients and in most cases it is transient [1, 2]. It can be caused by surgical injury: parathyroid ischaemia, unintended parathyroidectomy (e.g. resection of the parathyroid gland located within the thyroid lobe – i.e. intraglandularly) or hemodilution [3, 4].

Risk factors include: perioperative level of native parathyroid hormone (PTH), calcium level variations [5], female gender, surgery on patients with thyroid cancer, hyperactive goiter, intraoperative parathyroid injury and parathyroid autotransplantation [6]. One of the most commonly assessed parameters is the blood level of vitamin D. Authors of many publications consider vitamin D as hypocalcemia risk factor [6, 7, 8, 9, 10]. Studies which analyzed blood concentration of 25-hydroxycholecalciferol (25-OHD) of the inhabitants of Lodz and the rest of Poland, indicate significant deficiencies in 42.2%–81.1% of the examined population [11, 12]. PH occurs subclinically – can be assessed only by laboratory

tests, or symptomatically. It can be transient or permanent. The permanent form of PH leads to decreased life quality, increased incidence of renal complications or even psychic disturbances [13, 14, 15, 16]. The occurrence of early PH prolongs hospital stay and increases treatment costs [2, 14]. Many investigators attempt to find noninvasive methods which would allow to prevent postoperative HP. In studies referred to below, the following approaches were compared: efficacy of routine, prophylactic supplementation of calcium salts or vitamin D, and combined supplementation of calcium and vitamin D, used in various regimens in patients with benign and malignant thyroid diseases (Tab. I, Tab. II).

STUDIES EVALUATING CALCIUM SUPPLEMENTATION

In 4 studies calcium supplementation was evaluated [17, 18, 19, 20]. It was administered in groups of patients before surgery [18] and in postoperative period [17, 19, 20]. Duration of supplementation ranged from 5 hours (intravenous supplementation) [17] to one [19] and two weeks [18, 20]. Obtained results were compared with the group without supplementation. In Oltman 2015 [18]

the incidence of postoperative hypocalcemia in patients with Grave's Disease (GD) was compared in groups with and without supplementation and additionally in control group with other thyroid diseases without supplementation. In Roh 2009 [20] patients with papillary thyroid cancer were compared with those without central lymphadenectomy and pharmacological prophylaxis of hypocalcemia. Calcium supplementation increased the postoperative calcium level [17, 18], reduced the risk of transient laboratory hypocalcemia (LH) (24.5% vs. 44%) and symptomatic hypocalcemia (SH) (6–34.6% vs. 26–40.7%) [18, 19], as well as the risk of calcium level decrease in the postoperative period [18]. It also reduced the intensification of symptoms, discomfort and anxiety of patients [17]. In Roh 2009 [20] in a group with supplementation and central lymphadenectomy, the incidence of LH and SH was however higher than in the control group without interventions. In groups with supplementation neither hypocalcemia, nor PTH inhibition occurred [17, 20]. No statistically significant differences in remaining hypocalcemia were reported on or studied in the groups with applied prophylaxis and those without supplementation in the above mentioned studies [17, 20].

STUDIES EVALUATING SUPPLEMENTATION OF VITAMIN D AND ITS DERIVATIVES

In the first study [21] oral calcitriol with thiazide diuretic were supplemented in the week preceding surgery. The second one [22] evaluated the efficacy of periprocedural, oral alfacalcidol supplementation. Reduction of the incidence of LH in patients with supplementation was observed – in the first 24 h 33% vs. 37%, in the next 24 h 6% vs. 14% [22]. Also the incidence of SH was reduced in the group with supplementation (5–11% vs. 22–50%) [21, 22]. Patients with severe hypocalcemia (<1.9 mmol/L) receiving supplementation achieved calcium level normalization faster [22] and the length of hospitalization stay was shorter (2.4 ± 0.6 days vs. 3.6 ± 1.4 days) [21]. Supplementation with alfacalcidol did not affect the occurrence of permanent hypocalcemia [22].

STUDIES EVALUATING SUPPLEMENTATION OF CALCIUM AND VITAMIN D

The efficacy of combined supplementation of calcium and vitamin D was evaluated in eight studies [19, 20, 23, 24, 25, 26, 27, 28]. Vitamin D or its derivatives (calcitriol, alfacalcidol, cholecalciferol) and calcium were administered orally in the period ranging from a few days to a few weeks after surgery [19, 20, 23, 24, 25, 26], and in two studies – Jaan 2017 [27] and Docimo 2012 [28] – in the perioperative period. The incidence of LH was lower in the groups with supplementation (8.6%–25% vs. 32.9%–59%) [20, 23, 25, 27, 28]. The same was observed for SH incidence (1.9–23.4% vs. 4.5–54.5%) [19, 20, 23, 24, 25, 26, 27, 28]. Symptoms of hypocalcemia were milder and patients needed intravenous infusion of calcium less frequently [19, 23, 24, 27]. In Roh 2009 the incidence of hypocalcemia was lower also in the control group without lymphadenectomy (LH – 8.6% vs. 14.3%; SH – 2.0–6.1%) [20]. In Choe 2011 patients were divided into 4 groups with postoperative administration of: calcium with cholecalciferol or calcium with calcitriol, routinely or “on demand” [25]. In the group with supplementation “on demand”, in which drugs were administered after the occurrence of the symptoms,

calcium levels were higher in the patients receiving calcium with calcitriol, which suggests that it acts faster than the calcium cholecalciferol regimen.

Calcium level normalization was achieved faster in the intervention groups [20, 23, 27]. Also the length of hospital stay in those groups was shorter (1.2 ± 0.4 vs. 2.9 ± 0.9) [24]. Routine administration of calcium and vitamin D was related with lower costs than performing laboratory tests [26]. Inhibition of PTH was not observed in the study or control groups [19, 20, 23, 25]. Administration of calcium and vitamin D did not influence the occurrence of permanent hypocalcemia [20, 23].

STUDIES COMPARING SUPPLEMENTATION OF CALCIUM WITH COMBINED SUPPLEMENTATION OF CALCIUM AND VITAMIN D

The comparison of efficacy of calcium supplementation with supplementation of calcium and vitamin D was performed in 5 studies [19, 20, 29, 30, 31]. Vitamin D or its derivatives (calcitriol, cholecalciferol, alfacalcidol) were administered orally. Prophylaxis was used in the postoperative period [19, 20, 29, 30] and in Nemade 2014 in the perioperative period [31]. In the group with double supplementation LH occurred less frequently than in the group with calcium supplementation only (4.2–8.2% vs. 24.5–29.1%) [20, 31]. A similar correlation in SH incidence was observed (1.7–23% vs. 6.7–41.6%) [19, 21, 30, 31].

In Tartaglia 2005 [29] the incidence of both tetany (defined by authors as spontaneous masseter muscle contraction and carpal spasm and the presence of serious and widespread parestheses with positive Trousseau's sign) and SH were the lowest in the group with the highest calcitriol dose (2 µg – 0% and 17.1%, 1 µg – 2.9% and 28.%, calcium – 7.4% and 22.%). Patients receiving calcium with vitamin D had milder symptoms and usually did not require intravenous calcium infusion [19, 31]. In those patients higher postoperative calcium levels were observed despite the type of thyroid disease (benign or malignant) [30]. Also normalization of calcium level in postoperative period was faster [20]. Inhibition of PTH was not observed [20, 29] and permanent hypothyroidism developed less frequently [19, 31].

Metaanalyses from Antakia 2015 [32] and Alhefdi 2013 [33] suggest that postoperative, combined supplementation of calcium and vitamin D is related with lower incidence of transitional hypocalcemia, compared to supplementation of calcium alone or no supplementation.

CONCLUSION

Studies claimed the advantage of perioperative, routine prophylaxis with supplementation compared to the lack of supplementation. Such an approach was also more economical. Authors demonstrated the highest efficacy of oral postoperative supplementation of calcium salts in conjunction with vitamin D.

The influence of prophylactic calcium and vitamin D supplementation on the occurrence of hypercalcemia or PTH secretion were not found.

Tab. I. Characteristics of groups and hypocalcemia definition in included studies.

STUDY	N	N WITH SUPPLEMENTATION	TC [%]	TT (%)	TT+CND (%)	TT + MRND (%)	AUTOTRANSPLANTATION OF PARATHYROID GLAND	DEFINITION OF HYPOCALCEMIA
Urano 2006	547	243	78	22	78	0	-	Symptomatic hypocalcemia
Oltman 2015	123	45	12,2	100	0	0	11,4	Symptomatic hypocalcemia
Bellantone 2002	79	52	6,3	100	0	0	-	Ca < 8 mg/dl
Roh 2009	197	49	100	25	57	18	8	Ca < 8 mg/dl
Testa 2006	42	22	73,8	100	0	0	0	Ca < 2,1 mmol/l
Genser 2014	219	111	38,8	78,1	21,9	0	9,1	Ca < 2 mmol/l
Roh 2006	90	45	83,3	79	0	21	21	Ca < 8 mg/dl / Ca++ < 1,0mmol/l
Kurukahvecioglu 2007	487	243	15,6	100	0	0	-	Symptomatic hypocalcemia requiring supplementation
Choe 2011	306	154	100	0	100	0	40,2	Ca < 0,8 mmol/l / Ca++ < 1 mmol/l
Jaan 2017	60	30	57,5	81,7	13,3	0	6,7	Ca < 8,5 mg/dl
Arer 2017	106	53	13,2	94,3	5,7	0	0	Symptomatic hypocalcemia
Docimo 2015	50	50	10	100	0	0	0	Ca < 8 mg/dl
Tartaglia 2005	417	202	20,6	100	0	0	0	Symptomatic hypocalcemia
Pisaniello 2005	120	60	11,7	100	0	0	-	Ca < 8 mg/dl
Nemade 2014	48	24	14,6	100	0	-	-	Ca < 8 mg/dl / Ca++ < 1 mmol/l

N – number of patients; TC – thyroid cancer; TT – thyroidectomy; CND – central neck dissection; MRND – modified radical neck dissection; Ca – calcium level; Ca++ – ionized calcium level.

Tab. II. Supplementation used in the studies.

STUDY	PERIOD OF SUPPLEMENTATION	STUDY GROUP	CONTROL GROUP
Urano 2006	perioperative (3 to 8 h after the procedure)	Ca i.v. (78-156 mg)	no supplementation
Oltman 2015	preoperative 2 weeks	Ca p.o. (3 g/d) no supplementation	no supplementation, no GD
Bellantone 2002	postoperative from the 1st to the 7th day	B Ca p.o. (3 g/d) C Ca p.o. (3 g/d) + calcitriol (1 µg/d)	A no supplementation
Roh 2009	postoperative 2 weeks	A TT + CND + Ca (3 g/d) + alfalcidol p.o. (1 µg/d) B TT + CND + Ca p.o. (3 g/d) C TT+CND no supplementation	TT, no CND, no supplementation
Testa 2006.	preoperative 1 week	calcitriol (1.5 µg/d) + thiazid diuretic p.o. (25 mg/d)	no supplementation
Genser 2016	perioperative 1 day before and 8 days after surgery	alfalcidol p.o. (2 µg/d)	no supplementation
Roh 2006	postoperative 2 weeks	Ca (3 g/d) + vitamin D p.o. (1 g/d)	no supplementation
Kurukahvecioglu 2007	postoperative 7 days	Ca (600 mg/d) + vitamin D p.o. (400 U/d)	no supplementation
Choe 2011	postoperative	A1 Ca (3 g/d) + cholecalciferol p.o. (20 µg/d) routinely A2 Ca (3 g/d) + calcitriol p.o. (5 µg/d) routinely	B1 like A1 „on demand” B2 like A2 „on demand”
Jaan 2011	perioperative 7 days before and 7 days after surgery	Ca (2 g/d) + calcitriol p.o. (1 µg/d)	no supplementation
Arer 2017	postoperative from the 24th hour after surgery for 7 days and then reduction of doses for the next 7 days	Ca + vitamin D p.o. ≤ 70 kg 5 g/d + 1760 U/d > 70 kg 7.5 g/d + 2640 U/d	no supplementation
Docimo 2012	perioperative 3 days before and 14 days after surgery	Ca (2 g/d) + vitamin D p.o. (800 U/d)	no control group
Tartaglia 2005	postoperative for approx. 15 days with gradual dose reduction	A Ca (1.5 g/d) + calcitriol (1 µg/d) p.o. B Ca (1.5 g/d) + calcitriol (2 µg/d) p.o.	C Ca p.o. (1.5 g/d)
Pisaniello 2005	postoperative from the 15th day after surgery	Ca (1500 mg) + cholecalciferol p.o. (400 U/d)	Ca p.o. (300 mg/d)
Nemade 2014	perioperative 1 week before and 2 weeks after surgery	Ca (2 g/d) + vitamin D p.o. (60000 U 3 times a week)	Ca p.o. (2 g/d)

i.v. – intravenously; p.o. – orally; Ca – calcium; TT – thyroidectomy; CND – central neck dissection; GD – Grave's Disease; /d – per day.

Groups of patients included in the majority of the studies were heterogeneous in the term of presurgical diagnosis. Patients with benign thyroid diseases, including GD and hyperactive multinodular goiter, and those with tumors of the thyroid were included. None of the stu-

dies evaluated calcium and vitamin D supplementation in the short, perioperative period only, which would have enabled better control of a researcher over patient's compliance during hospitalization. Prolonged hospitalization was also enforced by the regimens of the labo-

ratory tests. Inclusion and exclusion criteria did not eliminate many factors influencing calcium hemostasis. In the majority of the studies preoperative 25-OHD level was not evaluated [17, 18, 19, 20, 23, 24, 25, 27, 28, 29, 30, 31]. In Poland significant vitamin D deficiency is being observed. It may be necessary to assess preoperative 25-OHD levels and to implement an appropriate regimen based on the results.

REFERENCES:

1. Reeve T., Thompson N.W.: Complications of thyroid surgery: how to avoid them, how to manage them and observation on their possible effect on the whole patient. *World. J. Surg.* 2000; 24 (8): 971–975.
2. Kara M., Tellioglu G., Krand O. et al.: Predictors of hypocalcemia occurring after a total/near total thyroidectomy. *Surg. Today.* 2009; 39 (9): 752–757.
3. Lee G.H., Ku Y.H., Kim H.I., Lee M.C., Kim M.J.: Vitamin D level is not a predictor of hypocalcemia after total thyroidectomy. *Langenbecks Arch. Surg.* 2015; 400 (5): 617–622.
4. Wu S.D., Gao L.: Is routine calcium supplementation necessary in patients undergoing total thyroidectomy plus neck dissection? *Surg. Today.* 2011; 41 (4): 183–188.
5. Edafe O., Antakia R., Laskar N., Uttley L., Balasubramanian S.P.: Systematic review and meta-analysis of predictors of postthyroidectomy hypocalcaemia. *Br. J. Surg.* 2014; 101 (4): 307–320.
6. Ozogul B., Akcay M.N., Akcay G., Bulut O.H.: Factors Affecting Hypocalcaemia Following Total Thyroidectomy: A Prospective Study. *Eurasian J. Med.* 2014; 46 (1): 15–21.
7. Kim W.W., Chung S.H., Ban E.J. et al.: Is Preoperative Vitamin D Deficiency a Risk Factor for Postoperative Symptomatic Hypocalcemia in Thyroid Cancer Patients Undergoing Total Thyroidectomy Plus Central Compartment Neck Dissection? *Thyroid.* 2015; 25 (8): 911–918.
8. Tripathi M., Karwasra R.K., Parshad S.: Effect of preoperative vitamin D deficiency on postoperative hypocalcemia after thyroid surgery. *Thyroid Res.* 2014; 7: 8.
9. Kirkby-Bott J., Markogiannakis H., Skandarajah A., Cowan M., Fleming B., Palazzo F.: Preoperative Vitamin D Deficiency Predicts Postoperative Hypocalcemia After Total Thyroidectomy. *World J. Surg.* 2011; 35 (2): 324–330.
10. Erbil Y., Bozbor A., Ozbey N. et al.: Predictive Value of Age and Serum Parathormone and Vitamin D3 Levels for Postoperative Hypocalcemia After Total Thyroidectomy for Nontoxic Multinodular Goiter. *Arch. Surg.* 2009; 142 (12): 1182–1187.
11. Godala M., Materek-Kuśmierkiewicz I., Moczulski D. i wsp.: Ocena częstości występowania niedoborów witaminy 25(OH)D w osoczu mieszkańców Łodzi. *Pol. Merkur. Lekarski.* 2016; 40 (237): 164–167.
12. Kmiec P., Żmijewski M., Lizakowska-Kmiec M., Sworczak K.: Widespread vitamin D deficiency among adults from northern Poland (54°N) after months of low and high natural UVB radiation. *Endokrynol. Pol.* 2015; 66 (1): 30–38.
13. Cho N.L., Moalem J., Chen L., Lubitz C.C., Moore F.D. Jr., Ruan D.T.: Surgeons and patients disagree on the potential consequences from hypoparathyroidism. *Endocr. Pract.* 2014; 20 (5): 427–446.
14. Wolak S., Scheunchen M., Holzer K., Busch M., Trumpf E., Zielke A.: Impact of preoperative Vitamin D3 administration on postoperative hypocalcaemia in patients undergoing total thyroidectomy (HypoCalViD): study protocol for a randomized controlled trial. *Trials.* 2016; 17 (1): 101.
15. Underbjerg L., Sikjaer T., Mosekilde L., Rejnmark L.: Cardiovascular and renal complications to postsurgical hypoparathyroidism: a Danish nationwide controlled historic follow-up study. *J. Bone Miner. Res.* 2013; 28 (11): 2277–2285.
16. Underbjerg L., Sikjaer T., Mosekilde L., Rejnmark L.: Post-Surgical hypoparathyroidism - risk of fractures, psychiatric diseases, cancer, cataract, and infections. *J. Bone Miner. Res.* 2014; 29 (11): 2504–2510.
17. Uruno T., Miyauchi A., Shimizu K. et al.: A prophylactic infusion of calcium solution reduces the risk of symptomatic hypocalcemia in patients after total thyroidectomy. *World J. Surg.* 2006; 30 (3): 304–308.
18. Oltmann S.C., Brekke A.V., Schneider D.F., Schaefer S.C., Chen H., Sippel R.S.: Preventing postoperative hypocalcemia in patients with Graves disease: A prospective study. *Ann. Surg. Oncol.* 2015; 22 (3): 952–958.
19. Bellantone R., Lombardi C.P., Raffaelli M. et al.: Is routine supplementation therapy (calcium and vitamin D) useful after total thyroidectomy? *Surgery.* 2002; 132: 1109–1112.
20. Roh J.L., Park J.Y., Park C.I.: Prevention of postoperative hypocalcemia with routine oral calcium and vitamin D supplements in patients with differentiated papillary thyroid carcinoma undergoing total thyroidectomy plus central neck dissection. *Cancer.* 2009; 115 (2): 251–258.
21. Testa A., Fant V., De Rosa A. et al.: Calcitriol plus hydrochlorothiazide prevents transient post-thyroidectomy hypocalcemia. *Horm. Metab. Res.* 2006; 38 (12): 821–826.
22. Genser L., Tresallet C., Godiris-Petit G. et al.: Randomized controlled trial of alfacalcidol supplementation for the reduction of hypocalcemia after total thyroidectomy. *Am. J. Surg.* 2014; 207 (1): 39–45.
23. Roh J.L., Park C.I.: Routine oral calcium and vitamin D supplements for prevention of hypocalcemia after total thyroidectomy. *Am. J. Surg.* 2006; 192 (5): 675–78.
24. Kurukahvecioglu O., Karamercan A., Akin M. et al.: Potential benefit of oral calcium/vitamin D administration for prevention of symptomatic hypocalcemia after total thyroidectomy. *Endocr. Regul.* 2007; 41 (1): 35–39.
25. Choe J.H., Kim W.W., Lee S.K. et al.: Comparison of calcitriol versus cholecalciferol therapy in addition to oral calcium after total thyroidectomy with central neck lymph node dissection: A prospective randomized study. *Head Neck.* 2011; 33 (9): 1265–1271.
26. Arer I.M., Kus M., Akkapulu K. et al.: Prophylactic oral calcium supplementation therapy to prevent early post thyroidectomy hypocalcemia and evaluation of postoperative parathyroid hormone levels to detect hypocalcemia: A prospective randomized study. *Int. J. Surg.* 2017; 38: 9–14.
27. Jaan S., Sehgal A., Wani R.A., Wani K.A., Laway B.A.: Usefulness of pre- and post-operative calcium and Vitamin D supplementation in prevention of hypocalcemia after total thyroidectomy: A randomized controlled trial. *Indian J. Endocrinol. Metab.* 2017; 21 (1): 51–55.
28. Docimo G., Talone S., Pasquali D. et al.: Role of pre and post-operative oral calcium and vitamin D supplements in prevention of hypocalcemia after total thyroidectomy. *G. Chir.* 2012; 33 (11–12): 374–378.
29. Tartaglia F., Giuliani A., Sgueglia M., Biancari F., Juvonen T., Campana F.P.: Randomized study on oral administration of calcitriol to prevent symptomatic hypocalcemia after total thyroidectomy. *Am. J. Surg.* 2005; 190 (3): 424–429.
30. Pisaniello D., Parmeggiani D., Piatto A. et al.: Which therapy to prevent post-thyroidectomy hypocalcemia? *G. Chir.* 2005; 26 (10): 357–361.
31. Nemade S.V., Rokade V.V., Pathak N.A., Tiwari S.S., Sonkhedkar S.J.: Comparison Between Preoperative Treatment with Calcium and with Calcium and Vitamin D in Prevention of Post Thyroidectomy Hypocalcemia. *Indian J. Otolaryngol. Head Neck Surg.* 2014; 66 (Suppl 1): 214–219.
32. Antakia R., Edafe O., Uttley L., Balasubramanian S.P.: Effectiveness of Preventative and Other Surgical Measures on Hypocalcemia Following Bilateral Thyroid Surgery: A Systematic Review and Meta-Analysis. *Thyroid.* 2015; 25 (1): 95–106.
33. Alhefdi A., Mazeh H., Chen H.: Role of postoperative vitamin D and/or calcium routine supplementation in preventing hypocalcemia after thyroidectomy: a systematic review and meta-analysis. *Oncologist.* 2013; 18 (5): 533–542.

Word count: 2530 Page count: 5 Tables: 2 Figures: – References: 33

DOI: 10.5604/01.3001.0012.0975 Table of content: <https://ppch.pl/issue/11208>

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Competing interests: The authors declare that they have no competing interests.



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Cite this article as: Grzegory A., Pomorski L.; Perioperative calcium and vitamin D supplementation in patients undergoing thyroidectomy – literature review.; Pol Przegl Chir 2018; 90 (4): 47-51
