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Predictable Criteria for Selective, Rather Than Routine, Calcium Supplementation Following Thyroidectomy

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Objectives: To identify patients at risk for symptomatic hypocalcemia and to make recommendations for safe, selective calcium supplementation.

Design: Retrospective review of consecutive patients undergoing thyroidectomy. Patients were divided into 2 groups. Group 1 (the "high-risk/calcium-yes" group) included patients who were found to have (1) postoperative symptoms of hypocalcemia (ie, tingling and numbness), (2) any postoperative serum calcium level of less than 7 mg/dL, or (3) a parathyroid hormone level of less than 3 pg/mL on postoperative day 1. Group 2 (the "low-risk/calcium-no" group) included all other patients. Demographic, operative, biochemical, and pathologic data, as well as postoperative calcium supplementation data, were recorded. Trends in serum calcium level and parathyroid hormone level were analyzed during the immediate postoperative period to identify specific factors unique to group 1.

Patients: A total of 156 patients who underwent a thyroidectomy.

Setting: Tertiary care center.

Results: Of the 156 patients reviewed, 78% were female, 70% had a malignant disease, and the median age at operation was 50 years. Thirty-four patients (22%) were in group 1, and 122 patients (78%) were in group 2. Twenty-nine (19%) patients had a parathyroid hormone level of less than 3 pg/mL within 24 hours after a thyroidectomy. Patients who underwent a central neck dissection ($P=.001$), had malignant disease ($P=.01$), or had a documented removal of the parathyroid gland (with or without autotransplantation) at operation ($P=.013$) were most likely to be classified into group 1. Forty-two percent of patients in group 2 had either a parathyroid hormone level of less than 6 pg/mL or a serum calcium level of less than 8 mg/dL on postoperative day 1, but all patients in group 1 who were symptomatic met these parameters.

Conclusion: Limiting supplementation to patients with a parathyroid hormone level of less than 6 pg/mL or a serum calcium level of less than 8 mg/dL on postoperative day 1 may eliminate unnecessary calcium/vitamin D intake, phlebotomy, and follow-up assessments in up to 58% of patients undergoing thyroidectomy. Validation is required in a prospective setting.

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PATIENTS WITH HYPOCALCEMIC symptoms, a low parathyroid hormone (PTH) level (<3 pg/mL), or a low serum calcium level following a thyroidectomy require calcium supplementation. Prescribing calcium to all patients following a thyroidectomy, however, is more controversial. More than 50 000 thyroid operations are performed annually in the United States.[1] In some circumstances, parathyroid glands are intentionally removed at operation owing to the close proximity or direct involvement of a malignant tumor. Likewise, parathyroid glands are sometimes inadvertently damaged, devascularized, or removed during the procedure. These injuries may lead to the development of temporary hypoparathyroidism. The actual incidence of temporary hypoparathyroidism reportedly ranges from 1.6% to 50% across different centers.[2] To protect against symptomatic hypocalcemia after a thyroidectomy, many surgeons routinely discharge patients

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from the hospital but continue to treat them with calcium supplementation and/or calcitriol, the hormonally active form of vitamin D_3. The routine administration of supplemental calcium and calcitriol can be inconvenient, may lead to unwanted adverse effects such as constipation, and may inhibit PTH production by means of a negative feedback mechanism.[3] In addition, the burden

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of frequent biochemical assessments (ie, of serum calcium and PTH levels) after discharge from the hospital can be demanding for both the patient and the medical team. The aim of our study was to identify patients at risk for developing symptomatic hypocalcemia after completion or total thyroidectomy, and to create recommendations for safe, selective calcium/calcitriol supplementation.

METHODS

After institutional review board approval was obtained, we performed a retrospective review of 156 consecutive patients who underwent a total or a completion thyroidectomy with a consistent operative technique between July 2006 and October 2009. Patients with both benign and malignant diseases were included in our study. Patients with concomitant primary hyperparathyroidism or renal failure were excluded. The following patient information was obtained: age at operation, sex, type of thyroidectomy, pathologic diagnosis, sociodemographic and clinical characteristics, and perioperative biochemical parameters. Routine assessments of serum calcium level (not corrected for albumin level) and PTH level were obtained 2 hours after a thyroidectomy, at 5 PM on the evening of the procedure and at 5 AM the following morning. If the operation was completed after 3 PM, only 1 assessment was obtained 2 hours after completion of the operation. The PTH and calcium levels were assessed again at noon on the day following surgical intervention if the PTH level at 5 AM was less than 3 pg/mL. Serum calcium and PTH levels were obtained at follow-up clinic visits. Permanent hypoparathyroidism was defined as an undetectable PTH level that persisted for more than 6 months postoperatively. Temporary hypoparathyroidism was defined as a PTH level of less than 3 pg/mL during the immediate postoperative period that returned to a level of greater than 3 pg/mL within 6 months after the thyroidectomy.

Prior to discharge from the hospital, all patients and caregivers viewed an educational video describing the symptoms and treatment of hypocalcemia. In addition, patients were given written instructions reinforcing how to recognize clinical manifestations of hypocalcemia and were directed to consume calcium carbonate if symptoms developed. All patients were evaluated by a registered nurse during a telephone interview 2 days following hospital discharge. These evaluations were consistently recorded in the medical record. Occurrences of symptomatic hypocalcemia and the consumption of oral calcium supplementation were recorded during the hospitalization and after hospital discharge.

Patients were divided into 2 groups based on symptomatology and biochemical parameters during the postoperative period according to our proposed risk for developing symptomatic hypocalcemia. The "high-risk/calcium-yes" group (group 1) included patients who (1) had symptoms of hypocalcemia at any time during the postoperative course, (2) had a PTH level of less than 3 pg/mL on postoperative day 1, or (3) had a serum calcium level of less than 7 mg/dL on postoperative day 1. The "low-risk/calcium-no" group (group 2) included all other patients. Groups were compared according to age, sex, race, procedure, presence of malignancy, documented parathyroid gland removal at operation, concomitant central or lateral neck dissection, and number of lymph nodes removed. Statistical comparisons between groups were made using the χ^2 test or the Fisher exact test for categorical variables and the *t* test or the Wilcoxon rank sum test for continuous variables. Changes in serum calcium level were also evaluated during the postoperative period. The mean serum calcium change was defined as the difference in the value (in units of milligrams per deciliter) between blood samples. After comparing the outcomes of both groups, we then sought to create safe guidelines for clinicians to follow for selective calcium/calcitriol supplementation after thyroidectomy.

Table 1. Demographic and Clinical Characteristics of Patients Who Underwent a Thyroidectomy

Characteristics	Patients, No. (%) (N = 156)
Age at operation, mean (range), y	47 (5-83)
Race	
White	115 (74)
Black	11 (7)
Hispanic	11 (7)
Other	19 (12)
Sex	
Female	121 (78)
Male	35 (22)
Type of operation	
Near total thyroidectomy	9 (6)
Total thyroidectomy	133 (85)
Completion thyroidectomy	14 (9)
Type of central neck dissection	
Unilateral	57 (37)
Bilateral	21 (13)
None	78 (50)
Type of lateral neck dissection	
Unilateral	11 (7)
Bilateral	1 (1)
None	144 (92)
Pathology	
Papillary thyroid carcinoma	90 (58)
Medullary thyroid carcinoma	13 (8)
C-cell hyperplasia	6 (4)
Follicular thyroid carcinoma	5 (3)
Hurthle cell carcinoma	1 (1)
Benign	41 (26)

RESULTS

Of the 156 patients reviewed, 121 patients (78%) were women, 109 (70%) had a malignant disease, and the median age at operation was 50 years (**Table 1**). The majority of patients (ie, 115 of 156 patients [74%]) were white. Seventy-eight (50%) patients underwent a central neck dissection, and 12 (8%) underwent a lateral neck dissection. The majority of the patients had papillary thyroid carcinoma (ie, 90 patients [58%]). Twenty-five patients (16%) had an undetectable PTH level (below the lower limit of the assay procedure) during the postoperative period, with a median time to detectable PTH level of 13 days (range, 0.47-52 days). Of the 34 patients in group 1, 29 (85%) developed temporary hypoparathyroidism (PTH level, <3 pg/mL) during the postoperative course; the PTH level was later corrected to the normal range. No patient had permanent aparathyroidism at the 6-month follow-up visit. The last PTH and serum calcium levels on postoperative day 1 were obtained at mean (SD) and median times of 17.3 (6.7) hours and 15.7 hours, respectively, after completion of the operation.

Group 1 consisted of 34 patients (22%): 25 patients (74%) who became symptomatic (2 [6%] during hospitalization, 15 [44%] after hospital discharge, and 8 [24%]

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Table 2. Sociodemographic and Clinical Characteristics of 156 Patients Who Underwent a Thyroidectomy, by Calcium Supplementation

Characteristic	Patients, No. (%) Group 1	Group 2	*P* Value
Overall	34 (22)	122 (78.2)	
Age at operation, mean (SD), y	44 (16)	48 (16)	.24
Sex			
Female	31 (91)	90 (74)	.04
Male	3 (9)	32 (26)	
Type of operation			
Completion thyroidectomy	4 (12)	10 (8)	.81
Near total thyroidectomy	2 (6)	7 (6)	
Total thyroidectomy	28 (82)	105 (86)	
Type of central neck dissection			
Unilateral	15 (44)	42 (34)	.001
Bilateral	10 (29)	11 (9)	
None	9 (27)	69 (57)	
Type of lateral neck dissection			
Unilateral	4 (9)	7 (6)	.08
Bilateral	1 (3)	0 (0)	
None	29 (88)	115 (94)	
Malignant disease			
No	4 (12)	43 (35)	.01
Yes	30 (88)	79 (65)	
No. of parathyroid glands removed			
None	24 (71)	109 (89)	.013
≤1	8 (23)	8 (7)	
≥1	2 (6)	5 (4)	
Central lymph nodes, median (range), Total No.	5 (0-26)	1 (0-24)	.005
Tumor-positive central lymph nodes, median (range), No.	0 (0-7)	0 (0-12)	.98

both during hospitalization and after hospital discharge) and 9 asymptomatic patients (26%) with a PTH level of less than 3 pg/mL on postoperative day 1. Of these 34 patients, 22 (65%) had a PTH level of less than 3 pg/mL on postoperative day 1. Three patients (9%) had a serum calcium level of less than 7 mg/dL on postoperative day 1, and all of these patients became symptomatic (1 [3%] during hospitalization and 2 [6%] after hospital discharge). Of the 12 patients (35%) who were discharged without supplementation, 11 (92%) developed hypocalcemic symptoms during the postoperative period. Twenty-two patients (65%) in group 1 were discharged from the hospital with calcium supplementation and/or calcitriol.

Group 2 consisted of 122 patients (78%). Three patients in this group were discharged from the hospital with supplementation (one patient was given supplementation because of mental retardation and schizophrenia, with the concern that he would not recognize symptoms of hypocalcemia; one patient had an undetectable PTH level on postoperative day 1, but the level returned to 7 pg/mL by the time of hospital discharge on postoperative day 2; and one patient was instructed to consume calcium by another provider without our knowledge). At the time of hospital discharge, all 3 of these patients had a serum calcium level between 7 and 8 mg/dL and a PTH level of 6 pg/mL or greater; none of these patients developed hypocalcemic symptoms. The remaining 119 patients (98%) in group 2 were not discharged from the hospital with supplementation; of these remaining patients, 3 (3%) developed hypocalcemic symptoms (all 3 had a serum calcium level of >8 mg/dL for all blood samples and a PTH level of >9 pg/mL on postoperative day 1, and the symptoms appeared to be psychological in nature).

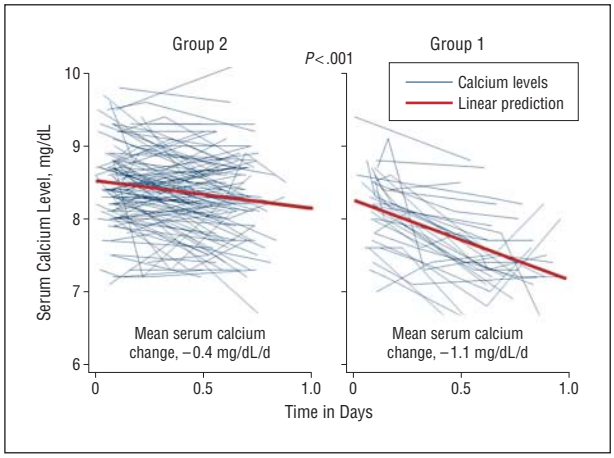

Figure. Serum calcium levels in 156 patients during the first 24 hours after a thyroidectomy.

Patients classified into group 1 were more likely to be women (*P*=.04), to have a malignant disease (*P*=.01), to have undergone a central neck dissection (*P*=.004), and to have had a parathyroid gland removed during thyroidectomy (*P*=.013) (**Table 2**). Likewise, patients in group 1 had a significantly higher number of central neck lymph nodes removed than did patients in group 2 (median number of central lymph nodes removed, 5 vs 1; *P*=.005). Age at operation, type of thyroidectomy, concomitant lateral neck dissection, preoperative vitamin D level, and number of tumor-positive lymph nodes were not significantly associated with patients in either group.

Trends in calcium levels during the postoperative period for both groups are shown in our **Figure**. The median number of serum calcium laboratory samples obtained during the first 24 hours after operation was 2.5 (range, 1-4). The average decrease in calcium levels during the first 24 hours after operation was –1.1 mg/dL (95% CI, –1.3 to –0.9 mg/dL) for group 1 and –0.4 mg/dL (95% CI, –1.0 to –0.4 mg/dL) for group 2 (*P*<.001).

Not every patient in group 1 developed symptoms, and not every patient who developed symptoms had a PTH level of less than 3 pg/mL or a calcium level of less than 7mg/dL. We further analyzed patients in group 1 to determine safe cutoff values for calcium and PTH levels on postoperative day 1 as a way to predict which patients would require calcium and/or calcitriol supplementation. We found that all symptomatic patients in group 1 either had a PTH level of less than 6 pg/mL and/or a serum calcium level of less than 8 mg/dL on postoperative day 1. By providing patients who meet this criteria with supplementation after hospital discharge, the highest-risk patients would be protected from developing symptomatic hypocalcemia. However, to protect the higher-risk patients, some of the lower-risk patients in group 2 would require supplementation. For instance, 32 pa-

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Table 3. Univariate Logistic Regression Analysis According to PTH Level

Characteristic	PTH Level on Postoperative Day 1, No. (%)		OR (95% CI)	*P* Value
	<6 pg/mL	≥6 pg/mL		
Overall	28 (18)	128 (82)		
Age, y				
<50	15 (54)	62 (48)		.62
≥50	13 (46)	66 (52)	0.8 (0.4-1.8)	
Sex				
Male	3 (11)	32 (25)		.11
Female	25 (89)	96 (75)	2.8 (0.8-9.8)	
Type of thyroidectomy				
Completion thyroidectomy	1 (4)	13 (10)		
Near total thyroidectomy	2 (7)	7 (6)	3.7 (0.3-48.5)	.32
Total thyroidectomy	25 (89)	108 (84)	3.0 (0.4-24.1)	.30
Type of central neck dissection				
None	5 (18)	73 (57)	1 [Reference]	.001
Bilateral or unilateral	23 (82)	55 (7)	6.1 (2.2-17.1)	
Type of lateral neck dissection				
None	25 (89)	119 (93)	1 [Reference]	.51
Bilateral or unilateral	3 (11)	9 (7)	1.6 (0.4-6.3)	
Parathyroid gland removed				
No	19 (68)	114 (89)	1 [Reference]	.006
Yes	9 (32)	14 (11)	3.8 (1.5-10.1)	
Malignant tumor				
No	2 (7)	45 (35)	1 [Reference]	.010
Yes	26 (93)	83 (65)	7.0 (1.6-31.1)	

Abbreviations: OR, odds ratio; PTH, parathyroid hormone.

tients (26%) in group 2 had a PTH level of less than 6 pg/mL and/or a serum calcium level of less than 8 mg/dL on postoperative day 1. Of the 156 patients from the entire data set, 66 (42%) had these levels on postoperative day 1. On the other hand, 90 patients (58%) from the entire data set would not require supplementation because, on postoperative day 1, they had PTH levels greater than 6 pg/mL and serum calcium levels greater than 8 mg/dL.

The surgical endocrine service algorithm for sending patients home with calcium when they had a PTH level of less than 6 pg/mL or a calcium level of less than 8 mg/dL was further analyzed when applied to the entire data set. All the potential covariates were examined independently according to which factors contribute to a PTH level of less than 6 pg/mL using logistic regression (**Table 3**). Serum calcium alone was not analyzed because it was not an independent variable. The univariate analysis indicated that patients with a central neck dissection were 6 times more likely than other patients to have a PTH level of less than 6 pg/mL (odds ratio, 6.1; *P*=.001), that patients who had at least 1 parathyroid gland removed were almost 5 times more likely than other patients to have a PTH level of less than 6 pg/mL (odds ratio, 4.9; *P*=.001), and that patients with a malignant disease were 7 times more likely than other patients to have a PTH level of less than 6 pg/mL (odds ratio, 7; *P*=.010).

The results of the multivariate logistic regression analysis indicated that the 2 best covariate models for predicting PTH levels of less than 6 pg/mL were central neck dissection and documented parathyroid removal at operation (**Table 4**). Malignant disease was not included in the final model owing to its strong association with central neck dissection. In the multivariate analysis, patients with a central neck dissection were 5.2 times more likely than other patients to have a PTH level of less than 6 pg/mL, and documented parathyroid gland removal increased the odds of a PTH level of less than 6 pg/mL by almost 4 times. The multivariate model (Table 3) created using the best subsets resulted in an area under the receiver operating characteristic curve of 74%.

Table 4. Multivariate Logistic Regression Analysis According to PTH Level

Comparison	OR (95% CI)	*P* Value
CND (bilateral or unilateral) vs no CND	5.3 (1.9-15.1)	.002
Parathyroid gland removed vs no parathyroid gland removed	2.8 (1.0-7.8)	.045

Abbreviations: CND, central neck dissection; OR, odds ratio; PTH, parathyroid hormone.

COMMENT

The purpose of our study was to identify specific parameters to use as a guide for selective calcium and/or calcitriol supplementation in patients who have undergone completion or total thyroidectomy. According to our analysis, patients are at greatest risk for developing symptomatic hypocalcemia if they undergo a central neck dissection for a malignant disease or if they have a docu-

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mented parathyroid gland removal at the time of operation. However, owing to the wide variability in surgical technique among surgeons, we used biochemical, objective parameters to determine which patients should receive supplemental therapy. Our model suggests that patients who have a PTH level of less than 6 pg/mL or a serum calcium level of less than 8 mg/dL on postoperative day 1 should be discharged from the hospital with calcium and/or calcitriol supplementation. By following this criteria, all of the patients in group 1 (the "high-risk/calcium-yes" group) would be sent home with supplementation. Likewise, some of the patients in group 2 (the "low-risk/calcium-no" group) who would not necessarily require supplementation would receive calcium and/or calcitriol. When applied to the entire patient data set, up to 58% of patients would theoretically not require calcium and would avoid other biochemical laboratory assessments.

Our recommendations are meant to be used as a guideline to protect the majority of patients after a thyroidectomy. We realize that, in the art of medicine, no method is 100% accurate. As a result, all patients should be educated on the clinical manifestations of hypocalcemia regardless of whether they are sent home with supplementation. In fact, 3 patients in group 2 developed symptoms of hypocalcemia even though all 3 had a serum calcium level of greater than 8 mg/dL and a PTH level of greater than 9 pg/mL on postoperative day 1. We believe that these symptoms were real but relative in nature and that the patients were not at risk of life-threatening cardiac dysfunction or tetany. However, some patients may be on other medications or may have unrecognized gastrointestinal absorptive problems that put them at higher risk for developing hypocalcemia. With appropriate education, patients who develop symptoms can inform their medical team early on about their initial symptoms so that treatment can be initiated and life-threatening situations from tetany can be avoided.

Routine calcium and/or calcitriol supplementation after a thyroidectomy can be burdensome. Not only does it require multiple doses throughout the day and laboratory assessments during the postoperative period, oral calcium has been known to cause nausea, a decreased appetite, and constipation.[4] In addition, unnecessary calcium or hypercalcemia may suppress normal parathyroid hormone secretion and may result in prolonged suppression of glands that may be mildly ischemic.[3] Our clinical management aims to keep serum calcium levels in the low-to-normal range to prevent unwanted PTH suppression.

The routine administration of calcium and/or calcitriol to patients who have undergone a thyroidectomy also comes with an added cost. Another laboratory assessment of serum calcium and PTH levels after hospital discharge is necessary to ensure PTH function and prevention of overt hypercalcemia. Although the actual cost of calcium alone is not exorbitant, calcitriol can be expensive, and the cost of biochemical testing can be significant. Even more onerous are the logistics associated with obtaining multiple biochemical assessments; patients and their families must attend follow-up appointments at laboratory diagnostic facilities. This is especially burdensome for patients who do not live within the immediate vicinity of their surgeon's office. Moreover, the responsible surgical team must follow up on every laboratory result after hospital discharge and must contact the patient to adjust dosages of calcium and/or calcitriol accordingly. The selective use of calcium and calcitriol supplementation after a thyroidectomy may help to decrease the expense and burden on the patient and medical team. Further cost analysis is necessary in a prospective setting to determine whether there is a significant difference in cost between selective and routine calcium and/or calcitriol supplementation.

Similarly, the ability to identify patients who are at high risk for developing symptomatic hypocalcemia at the time of hospital discharge may help to reduce the length of hospital stay.[5] According to the Agency for Healthcare Research and Quality, the mean length of stay for all patients undergoing thyroid procedures in 2007 was 2 days.[1] A longer stay is more expensive and is associated with a greater risk of hospital-acquired infection. The potential to reduce the duration of hospital stay across the United States using our parameters to discharge patients on postoperative day 1 may be significant.

The significance of the timing of PTH testing after operation as well as the level of PTH is debatable.[5-10] We elected to evaluate the latest PTH level and serum calcium level obtained on postoperative day 1 because those biochemical assessments are crucial to the surgeon determining whether to discharge the patient with supplementation. Repeated laboratory testing of high-risk patients on postoperative day 1 helped guide us in determining the doses of calcium and/or calcitriol and the timing of the next outpatient biochemical assessment.

Other clinicians have different preferences regarding the optimal timing of PTH testing as a predictor of hypocalcemia. For instance, Lombardi et al[7] evaluated 53 patients who underwent a total thyroidectomy and measured serum calcium and PTH levels 2, 4, 6, 24, and 48 hours postoperatively. They[7] concluded that a PTH level of less than 10 pg/mL 4 hours after a thyroidectomy was the strongest predictor of developing a serum calcium level of less than 8 mg/dL. The Australian Endocrine Guidelines, published in 2007, adopted the recommendations of Lombardi et al[7] to standardize obtaining a PTH level 4 hours after a thyroidectomy.[6] Later, Lombardi et al[11] refuted the reliability of a 4-hour postoperative PTH level after applying their hypothesis to a larger patient population.

Some studies[12,13] have suggested measuring PTH levels 1 and 6 hours after a thyroidectomy and then using the percentage decreases in PTH and calcium levels as a guide to predict the development of hypocalcemia. Others recommend using a PTH level of less than 15 pg/mL obtained 1 hour after surgery.[8] Moreover, some centers have integrated an intraoperative quick PTH assay into their practice. In this setting, the intraoperative quick PTH assay is performed at the induction of anesthesia and 10 minutes after the total thyroidectomy is completed. The associated decrease in the PTH level is used as a determinant for the risk of hypocalcemia.[14] The wide variability of the predictors for the development of hypocalce-

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mia across centers suggests that the measurement of PTH level at any time in the postoperative period may be a reliable predictor of hypocalcemia.[10]

We do not believe that obtaining a PTH level less than 6 hours after an operation is the optimal time to predict the need for calcium and/or calcitriol supplementation after discharge from the hospital. In our series, some patients who developed transient hypoparathyroidism (PTH level, <3 pg/mL) on the evening of their thyroidectomies did not require supplemental calcium and/or calcitriol because their PTH functions recovered overnight. For centers that routinely discharge patients on the same day as their thyroidectomies, we recommend obtaining a serum calcium level and a PTH level prior to hospital discharge and another biochemical assessment the following morning at an outpatient laboratory.

These data are important for several reasons. The majority of thyroid operations are performed by low-volume surgeons across the United States.[15] In fact, more than 35% of thyroid procedures performed in 2007 were performed in rural or small metropolitan settings. Frequently, smaller community hospitals do not have the PTH assay readily available. As a result, the PTH level cannot be used to determine whether patients will be discharged from the hospital with calcium and/or calcitriol supplementation. We have found that a decrease in the serum calcium level of greater than 1.1 mg/dL during the first 24 hours in the postoperative period places patients at a higher risk of developing symptomatic hypocalcemia. Clinicians can use this information in conjunction with phosphorous levels, which follow an inverse relationship with PTH levels.[16] Likewise, other factors contributing to the development of hypocalcemia should be considered, such as whether parathyroid gland tissue was removed during the operation and whether a central neck dissection was performed.

There are several limitations to our study. First, our study was performed retrospectively. We cannot be certain whether every patient who developed symptomatic hypocalcemia accurately reported it. Also, the serum calcium level, rather than the corrected calcium level using albumin, was used as a parameter to determine the calcium status in patients because the nutritional status of all of the patients was presumed to be normal. Moreover, the ionized calcium level was not used as a parameter to measure calcium because it has been shown that ionized calcium is not reliable in the postoperative setting.[17]

We recommend that patients with a serum calcium level of less than 8 mg/dL or a PTH level of less than 6 pg/mL on the morning after a total or completion thyroidectomy should receive calcium and/or calcitriol supplementation after discharge from the hospital. The true safety, efficacy, and feasibility of these parameters can only be determined in a prospective setting in a larger patient population. Further evaluation with a prospective clinical trial is warranted.

Selective, rather than routine, calcium replacement therapy may be safe and achievable. Patients who have a PTH level of less than 6 pg/mL or a serum calcium level of less than 8 mg/dL at the time of hospital discharge should be sent home with calcium and/or calcitriol supplementation. The clinical implementation of these recommendations may eliminate unnecessary medications, phlebotomies, and follow-up assessments in up to 58% of patients undergoing a thyroidectomy. Moreover, the use of these postoperative criteria could result in significant cost savings, shorter hospital stays, and easier follow-up. Our recommendations require validation in a prospective setting.

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INVITED CRITIQUE

"Selective Rather Than Routine"

Using Sound Clinical Judgment

Landry and colleagues[1] argue that the "routine" administration of calcium and calcitriol after a total thyroidectomy, although aimed at reducing the risk of symptomatic hypocalcemia in the setting of early hospital discharge, comes at a cost. In this era of clinical pathways, standardized protocols, published guidelines, and computerized discharge instructions, it is tempting for surgical residents to just press a computer button and send patients home with a standard package of instructions and medications. When we first attempted to introduce a policy of "routine" calcium/calcitriol supplementation into our unit following total thyroidectomy, there was a 12% readmission rate for hypercalcemia. Many of these patients developed significant nausea and vomiting, which indicated a failed strategy that came at a significant cost. Likewise, the alternative of measuring intraoperative parathyroid hormone levels also incurred significant costs. The equipment and the technician time were expensive and not widely available in many good local hospitals that currently perform total thyroidectomy safely. Comprehensive guidelines, such as those published by the Australian Endocrine Surgeons,[2] have a tendency to be overlooked because of their complexity. Indeed, less than 30% of our own surgical residents were found to be in compliance with these published guidelines. Landry and colleagues[1] have described a simple approach: the clinical postoperative assessment for symptoms of hypocalcemia, which is then followed by the measurement of serum calcium and parathyroid hormone levels the morning after surgery. This approach can be performed either in the hospital, if the patient stays overnight, or in an outpatient laboratory for centers that routinely discharge patients the day of surgery. When I was a medical student, this approach was called "sound clinical judgment."

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