

Predictive Value of Early Postoperative Parathyroid Hormone Changes for Permanent Hypoparathyroidism After Thyroidectomy: A Retrospective Case- Control Study

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Abstract

Objective

To evaluate the predictive value of early postoperative parathyroid hormone (PTH) levels and perioperative changes in PTH for permanent hypoparathyroidism following thyroidectomy.

Materials and Methods

A total of 220 patients who underwent thyroid surgery were included in this retrospective case-control study. Patients were divided into two groups: 110 patients with permanent hypoparathyroidism and 110 patients without permanent hypoparathyroidism. Serum PTH and calcium (Ca) levels were evaluated preoperatively, on postoperative day 1, and at postoperative month 12. Between-group comparisons were performed for preoperative, postoperative day 1, and postoperative month 12 biochemical parameters.

Results

No statistically significant difference was observed between the groups in preoperative PTH levels ($p = 0.189$) or postoperative day 1 PTH levels ($p = 0.838$). Similarly, preoperative serum Ca levels did not differ significantly between the groups ($p = 0.221$), and no significant difference was observed in postoperative day 1 Ca levels ($p = 0.490$). In contrast, both PTH and Ca levels at postoperative month 12 were significantly different between the groups ($p = 0.001$ for both). The ROC analysis of the percentage change in PTH from the preoperative measurement to postoperative day 1 showed an area under the curve (AUC) of 0.509 ($p = 0.82$; 95% CI, 0.415–0.567). The ROC analysis of the absolute postoperative day 1 PTH level yielded an AUC of 0.521 ($p = 0.59$; 95% CI, 0.444–0.598). Neither analysis demonstrated statistically significant discriminatory ability.

Conclusions

In this study, neither the absolute postoperative day 1 PTH level nor the percentage change in PTH from the preoperative measurement to postoperative day 1 significantly discriminated patients with permanent hypoparathyroidism from those without permanent hypoparathyroidism. In contrast, PTH and serum Ca levels at postoperative month 12 were significantly different between the groups. These findings suggest that early postoperative PTH assessment alone may not be sufficient to predict permanent hypoparathyroidism.

Introduction

Postoperative hypoparathyroidism is one of the most important complications of bilateral thyroid surgery. Direct injury to the parathyroid glands during surgery, impairment of their vascular supply, inadvertent removal, or loss of function due to surgical manipulation are among the main causes of postoperative hypoparathyroidism.^{1,2} Permanent hypoparathyroidism may lead to important clinical consequences, including the need for long-term calcium and active vitamin D treatment, symptoms related to hypocalcemia, and impaired quality of life.^{1,3} The incidence of postoperative hypoparathyroidism varies depending on the diagnostic criteria used, the extent of surgery, and the duration of follow-up. Differences in the definitions of transient and permanent hypoparathyroidism also contribute to variations in the rates reported in the literature.^{2,4} According to current recommendations, persistent parathyroid dysfunction following thyroid surgery is considered permanent or chronic postsurgical hypoparathyroidism.^{1,2} The primary approach to preventing permanent hypoparathyroidism is to preserve the parathyroid glands and their vascular supply as much as possible during surgery.^{1,5} However, parathyroid glands that appear anatomically preserved during surgery may not always retain normal function. Therefore, biochemical assessment of parathyroid function in the postoperative period is important for the early identification of patients at risk of hypoparathyroidism.^{1,5} Parathyroid hormone (PTH) is one of the most important biochemical markers for the assessment of parathyroid function. Because of the short serum half-life of PTH, acute changes in parathyroid function can be reflected early in serum PTH levels. Therefore, early postoperative PTH measurement may allow the detection of parathyroid dysfunction before changes in serum calcium become apparent.^{3,5,8} The value of early postoperative PTH measurement in predicting permanent hypoparathyroidism has been investigated in several studies. Calvo Espino et al. reported that intact PTH levels measured on the first day after total thyroidectomy had high diagnostic performance in predicting permanent hypoparathyroidism.⁴ Similarly, several studies have demonstrated that postoperative day 1 PTH levels may be used to identify the risk of developing permanent hypoparathyroidism.^{5,6,11} In addition to the absolute PTH value, changes relative to the preoperative value have also been suggested to have prognostic value. In the study by Loncar et al., a reduction of more than 70% in PTH levels on postoperative day 1 was reported to be associated with persistent hypoparathyroidism at one-year follow-up, and this change demonstrated high diagnostic performance in ROC analysis.⁶ This approach may partially eliminate differences in baseline PTH levels among patients and allow assessment of the relative change in postoperative parathyroid function. Serum calcium levels are also an important parameter in the assessment of postoperative parathyroid function. However, changes in serum calcium may occur later than changes in PTH and may be influenced by several factors, including albumin levels, vitamin D status, renal function, and postoperative calcium treatment.^{1,7,13} Therefore, evaluation of PTH together with serum calcium during the early postoperative period is recommended.^{3,11} There are considerable differences in the cutoff values and timing of PTH measurements used in the literature. While low postoperative PTH levels have been identified as a strong marker of permanent hypoparathyroidism in some studies, the prognostic value of changes in PTH has been found to be more limited in others.^{4,6,9} These differences may be attributable to variations in patient populations, surgical techniques, timing of PTH measurement, laboratory methods, and definitions of permanent hypoparathyroidism.^{2,9,10} In this study,

preoperative, postoperative day 1, and postoperative month 12 PTH and serum calcium levels were compared in a total of 220 patients, including 110 patients who developed permanent hypoparathyroidism following thyroid surgery and 110 patients who did not develop permanent hypoparathyroidism. The primary aim of the study was to evaluate the diagnostic value of early postoperative PTH levels, as well as the change in PTH from the preoperative period to postoperative day 1, in predicting permanent hypoparathyroidism.

Materials and Methods

Study Design and Patient Population

This study was designed as a retrospective observational study comparing patients who developed permanent hypoparathyroidism with those who did not develop permanent hypoparathyroidism during the postoperative period after retrospectively screening 3,154 patients who underwent total thyroidectomy. Long-term postoperative clinical and biochemical follow-up data were used to identify patients with permanent hypoparathyroidism. In particular, the postoperative month 12 assessment was used as the primary time point for evaluating the persistence of parathyroid dysfunction. A total of 220 patients were included in the study. Of these, 110 patients constituted the permanent hypoparathyroidism group, while 110 patients without permanent hypoparathyroidism constituted the normal group. The primary aim of the study was to evaluate the association between preoperative and early postoperative parathyroid hormone (PTH) and serum calcium (Ca) levels and the development of permanent hypoparathyroidism, and particularly to investigate the diagnostic value of postoperative day 1 PTH changes in predicting permanent hypoparathyroidism. The demographic characteristics of the patients and their preoperative, postoperative day 1, and postoperative month 12 PTH and Ca levels were retrospectively evaluated. The inclusion criteria were as follows: adult patients who had undergone thyroid surgery; patients with an adequate duration of postoperative follow-up for the diagnosis of permanent hypoparathyroidism; patients with available preoperative PTH and Ca measurements; patients with available postoperative day 1 PTH and Ca measurements; patients with available postoperative month 12 PTH and Ca measurements; and patients with sufficient clinical and laboratory data to allow classification into one of the two study groups. Patients with known primary or secondary parathyroid disease in the preoperative period, preexisting hypocalcemia or hypoparathyroidism before thyroid surgery, previous neck surgery that could affect the assessment of parathyroid function, systemic diseases that could significantly affect calcium-phosphate metabolism such as chronic renal failure, missing essential preoperative or postoperative PTH/Ca measurements, unavailable postoperative day 1 or month 12 follow-up data, or an inability to definitively classify permanent hypoparathyroidism status were excluded from the study.

Biochemical Assessment

Preoperative PTH and serum Ca levels, as well as postoperative day 1 and postoperative month 12 values, were recorded. PTH levels were expressed in pg/mL, and serum Ca levels were expressed in mg/dL. Laboratory reference ranges of 15–60 pg/mL for PTH and 8.5–10.3 mg/dL for serum Ca were used. In addition to the absolute biochemical values, the change and percentage change in PTH from the preoperative value to the postoperative day 1 value were also evaluated. This approach aimed to investigate the potential contribution of the relative change in early parathyroid function to the prediction of permanent hypoparathyroidism.

Statistical Analysis

Statistical analyses were performed using appropriate statistical software. The normality of continuous variables was assessed using the Shapiro–Wilk test. The Mann–Whitney U test was used to compare non-normally distributed continuous variables between two independent groups. Categorical variables were expressed as numbers and percentages, as appropriate. The diagnostic performance of the absolute postoperative day 1 PTH level and the percentage change in PTH from the preoperative measurement to postoperative day 1 in discriminating permanent hypoparathyroidism was evaluated using receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC) and 95% confidence interval (CI) were calculated for the ROC analyses. A **p value < 0.05** was considered statistically significant.

Results

A total of 220 patients were included in the study. Of these, 110 patients had permanent hypoparathyroidism, while 110 patients constituted the normal group without permanent hypoparathyroidism. The demographic and clinical characteristics of the study groups are presented (Table 1). Preoperative PTH levels did not differ significantly between patients with permanent hypoparathyroidism and the normal group (**p = 0.189**). Similarly, no statistically significant difference was observed between the groups in postoperative day 1 PTH levels (**p = 0.838**). In contrast, postoperative month 12 PTH levels were significantly different between the two groups (**p = 0.001**). A similar pattern was observed for serum calcium levels. There was no statistically significant difference between the groups in preoperative serum Ca levels (**p = 0.221**) or postoperative day 1 Ca levels (**p = 0.490**). However, serum Ca levels at postoperative month 12 differed significantly between the groups (**p = 0.001**). The preoperative, postoperative day 1, and postoperative month 12 biochemical measurements of the groups are summarized (Table 2). The diagnostic performance of the percentage change in PTH from the preoperative measurement to postoperative day 1 for predicting permanent hypoparathyroidism was evaluated using ROC curve analysis. The area under the curve (AUC) was **0.509** (95% CI, 0.415–0.567; **p = 0.82**), indicating no statistically significant discriminatory ability for permanent hypoparathyroidism (Fig. 1). ROC curve analysis was also performed to evaluate the diagnostic performance of the absolute postoperative day 1 PTH level for predicting permanent hypoparathyroidism. The AUC was **0.521** (95% CI, 0.444–0.598; **p = 0.59**). This analysis also failed to demonstrate statistically significant discriminatory ability for permanent hypoparathyroidism (Fig. 2).

Overall, neither the absolute postoperative day 1 PTH level nor the percentage change in PTH from the preoperative measurement to postoperative day 1 showed significant predictive performance for permanent hypoparathyroidism. In contrast, both PTH and serum Ca levels at postoperative month 12 were significantly different between patients with and without permanent hypoparathyroidism.

Table 1
Demographic characteristics of the study groups.

Group	N	Gender (F/M)	AGE (Min-Max/Mean±SD)
Normal	110	75 F/35 M	18-76/46,9±12,8
Patient	110	78 F/32 M	19-73/44,6±11,9

Table 2

Comparison of Preoperative, Postoperative Day 1, and Postoperative Month 12 PTH and Calcium Levels Between the Study Groups

Group	N	PTH (Min/Max), (Mean ± SD) (Preoperative), (Postoperative Day 1), (Postoperative Month 12)	CA (Min/Max),(Mean ± SD) (Preoperative), (Postoperative Day 1), (Postoperative Month 12)	PTH (Preoperative), (Postoperative Day 1), (Postoperative Month 12)	CA (Preoperative), (Postoperative Day 1), (Postoperative Month 12)
Normal	110	(12,8/60), (40,7 ± 13,5), (2,4/60), (19,1 ± 15,2), (1,2/14,9), (7,5 ± 4,3)	(8,53/10,9), (9,2 ± 0,41), (7,65/10,3), (8,9 ± 0,5), (6,2/11,6), (8,6 ± 0,8)	p value 0,189 0,838 0,001	p value 0,221 0,490 0,001
Patient	110	(9,84/60), (37,8 ± 12,6) (1,2/60), (18,7 ± 16,3) (1,2/14,9), (7,5 ± 4,3)	(8,5/10,3), (9,2 ± 0,3) (7,37/11,96), (8,8 ± 0,5) (6,2/11,6), (8,6 ± 0,8)		
Data are presented as minimum–maximum and mean ± standard deviation (SD). PTH, parathyroid hormone; Ca, calcium.					

Discussion

In this study, 110 patients who developed permanent hypoparathyroidism following thyroid surgery were compared with 110 patients who did not develop permanent hypoparathyroidism. The main finding of our study was that there were no statistically significant differences between the groups in preoperative or postoperative day 1 PTH levels, whereas a significant difference was observed in postoperative month 12 PTH levels. Similarly, no significant differences were found between the groups in preoperative or postoperative day 1 serum calcium levels, whereas a statistically significant difference was observed at postoperative month 12. The importance of PTH in the postoperative assessment of parathyroid function is related to its short half-life and its ability to reflect changes earlier than serum calcium.^{1,3,8} Therefore, early postoperative PTH measurement is considered an important biochemical tool that may facilitate the identification of patients at risk, particularly before the development of hypocalcemia.^{5,11} There are important studies in the literature supporting the value of postoperative day 1 PTH in predicting permanent hypoparathyroidism. Calvo Espino et al. reported that postoperative day 1 PTH levels showed high diagnostic performance in predicting permanent hypoparathyroidism.⁴ Similarly, low early postoperative PTH levels have been shown to be an important risk indicator for long-term loss of parathyroid function in different cohorts.^{5,6,11} However, in our study, no significant difference was observed between the groups in postoperative day 1 PTH levels. This finding differs from those of some previous studies. However, the diagnostic performance of PTH may be influenced by the cutoff value used, timing of measurement, patient population, surgical procedure, and definition of permanent hypoparathyroidism.^{2,4,9} In particular, assessment of the change in PTH relative to the preoperative value has attracted attention in recent years. Loncar et al. demonstrated that a reduction of more than 70% in PTH levels on postoperative day 1 was associated with an increased risk of persistent hypoparathyroidism at one-year follow-up.⁶ In contrast, in our study, neither the percentage change in PTH from the preoperative measurement to postoperative day 1 nor the absolute postoperative day 1 PTH level demonstrated significant discriminatory ability for permanent hypoparathyroidism. These findings indicate that, in contrast to some of the strong prognostic results reported in the literature, early postoperative PTH assessment alone did not discriminate permanent hypoparathyroidism with sufficient accuracy in our patient population. There may be several reasons for this difference. First, the timing of PTH measurement and the cutoff values used vary among studies.^{4,6} In addition, the follow-up periods and biochemical criteria used to define permanent hypoparathyroidism also differ.^{2,9} Furthermore, factors such as surgical technique, vascular status of the parathyroid glands, central lymph node dissection, and postoperative calcium/vitamin D treatment may affect early PTH levels.^{1,5,10} The significant difference in postoperative month 12 PTH levels between the groups in our study suggests that, in contrast to early changes in PTH, long-term PTH levels more clearly reflect permanent hypoparathyroidism status. Long-term follow-up is important in the assessment of permanent hypoparathyroidism because parathyroid function may recover over time in some patients with low PTH levels during the early postoperative period.⁹ Our serum calcium results also support these findings. No significant difference was observed between the groups in preoperative Ca levels, and no significant

difference was found in postoperative day 1 Ca levels. In contrast, a statistically significant difference was observed between the groups in postoperative month 12 Ca levels. This finding suggests that serum calcium alone in the early postoperative period may be insufficient to reflect long-term parathyroid function.^{7,13} Therefore, the combined assessment of PTH and serum calcium is important. Although serum calcium may be affected by various metabolic and treatment-related factors during the postoperative period, PTH more directly reflects parathyroid gland function.^{1,3} Therefore, evaluating PTH together with Ca may provide a more comprehensive approach to determining the risk of postoperative hypoparathyroidism.^{11,13} One of the strengths of our study is that the two groups consisted of equal numbers of patients and that a total of 220 patients were evaluated. In addition, the availability of 12-month follow-up data allowed early transient parathyroid dysfunction to be distinguished from long-term permanent hypoparathyroidism. Furthermore, both the absolute postoperative day 1 PTH level and the percentage change in PTH from the preoperative measurement to postoperative day 1 were evaluated using ROC analysis. This study has several limitations. Owing to its retrospective design, the assessment of certain clinical and surgical variables was limited by the available patient records. In addition, the evaluation of PTH and Ca measurements at specific time points may have prevented the analysis of biochemical changes occurring at other time points. Detailed evaluation of variables such as surgical technique, intraoperative status of the parathyroid glands, autotransplantation, central lymph node dissection, and postoperative calcium/vitamin D treatment is important for future studies. In conclusion, no significant differences were observed between the groups in preoperative or postoperative day 1 PTH and Ca levels, whereas statistically significant differences were found in both PTH and Ca levels at postoperative month 12. In contrast, neither the absolute postoperative day 1 PTH level nor the percentage change in PTH from the preoperative measurement to postoperative day 1 demonstrated significant diagnostic performance for predicting permanent hypoparathyroidism in ROC analyses. These findings suggest that although PTH is an important biochemical marker, early changes in PTH alone may not be sufficient to predict permanent hypoparathyroidism in every patient population. Evaluation of PTH together with serum calcium and long-term biochemical follow-up may contribute to a more accurate assessment of the risk of permanent hypoparathyroidism.

Declarations

Ethics Approval and Consent to Participate

This study was approved by the Başakşehir Çam and Sakura City Hospital Clinical Research Ethics Committee, Başakşehir Çam and Sakura City Hospital (Decision No. 514, dated 08 April 2026). The study was conducted in accordance with the Declaration of Helsinki.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

A.B. conceived and designed the study, contributed to data collection and analysis, interpreted the results, and drafted the manuscript. B.G. contributed to data collection, data analysis, and interpretation of the results. Ö.Ö. contributed to data collection, interpretation of the findings. All authors reviewed and approved the final version of the manuscript.

Data Availability

Data are available from the corresponding author upon reasonable request.

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Figures

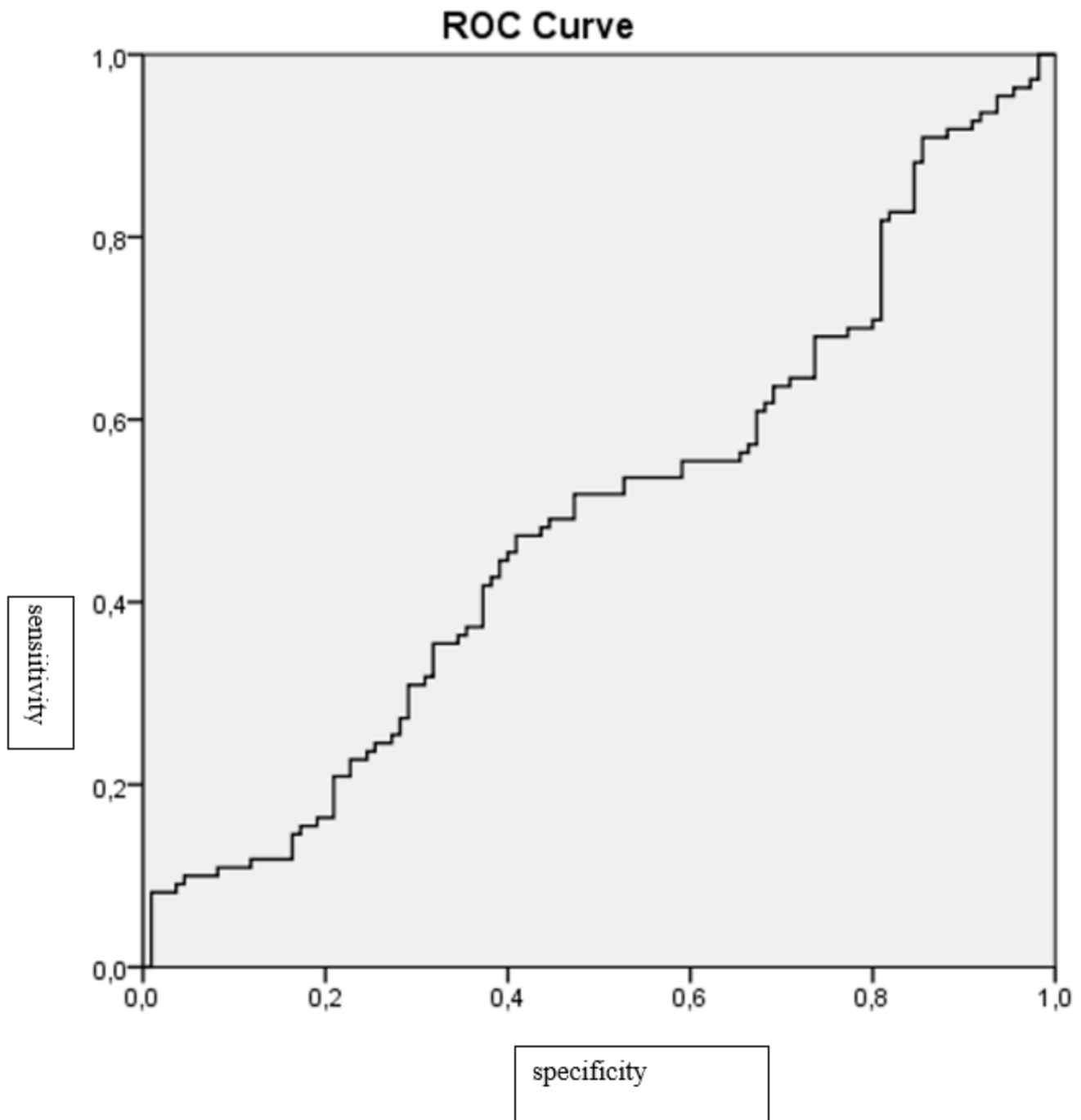


Figure 1

Receiver operating characteristic (ROC) curve analysis of the percentage decrease in PTH from the preoperative period to postoperative Day 1 for predicting permanent hypoparathyroidism. The analysis showed no significant discriminatory ability (AUC = 0.509, 95% CI: 0.415–0.567; $p = 0.82$).

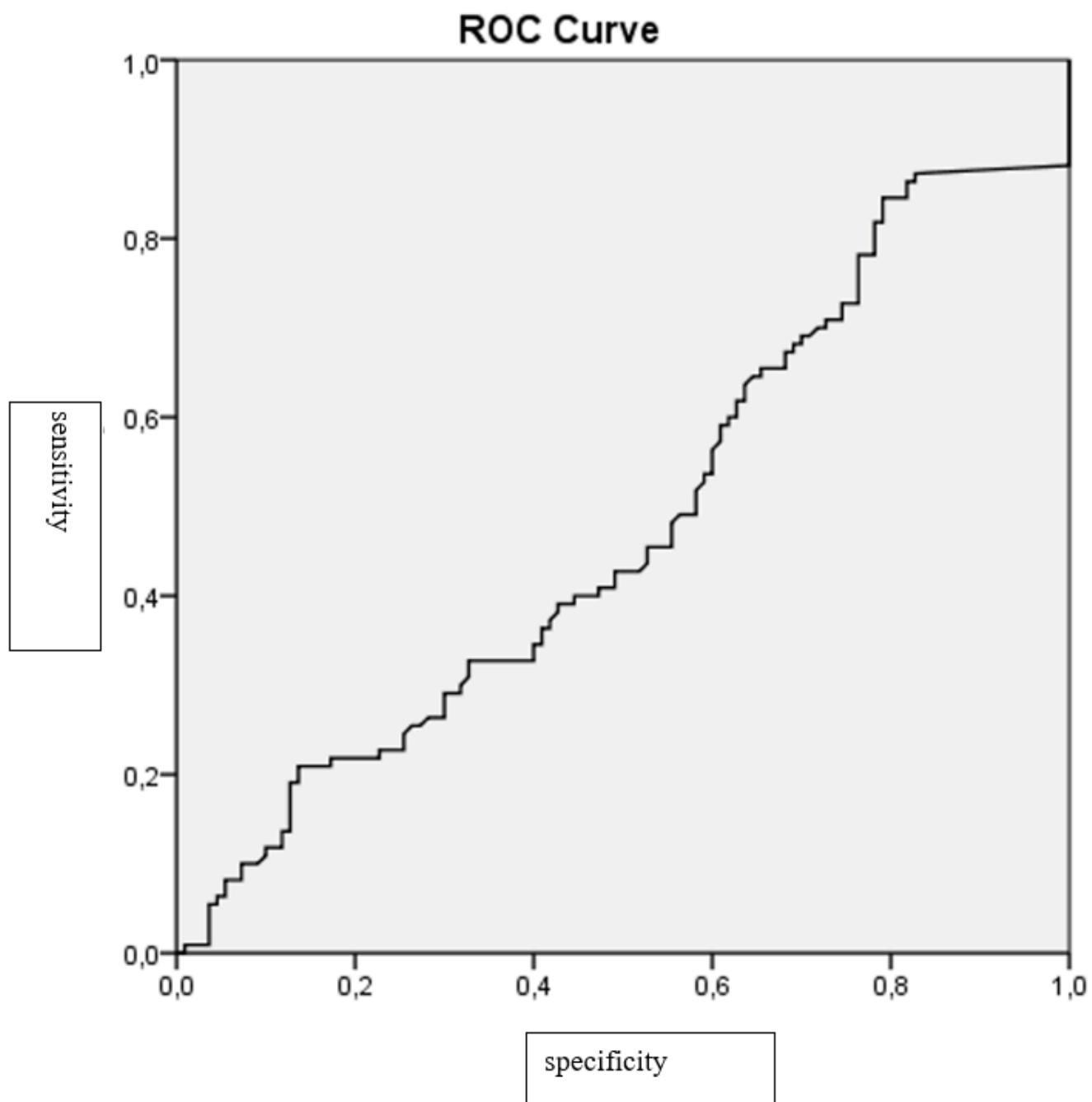


Figure 2

Receiver operating characteristic (ROC) curve analysis of the absolute postoperative Day 1 PTH level for predicting permanent hypoparathyroidism. The analysis showed no significant discriminatory ability (AUC = 0.521, 95% CI: 0.444–0.598; $p = 0.59$).