The Impact of Baseline Intact Parathyroid Hormone Levels on Severity of Primary Hyperparathyroidism and Outcomes in Patients Undergoing Surgery

Emad Kandil, MD; Haytham Alabbas, MD; Anthony P. Tufaro, MD; Kathryn A. Carson, ScM; Ralph P. Tufano, MD

Objective: To determine the impact of intact parathyroid hormone (iPTH) baseline levels on severity of primary hyperparathyroidism (PHPT) and outcomes following parathyroidectomy for PHPT.

Design: Single institution retrospective review.

Setting: Academic tertiary care center.

Patients: A total of 447 consecutive patients undergoing parathyroid surgery for PHPT.

Main Outcome Measures: Comparison of patients with high (≥150 pg/mL) and low (<150 pg/mL) baseline iPTH values; preoperative serum calcium, alkaline phosphatase, and 25-hydroxyvitamin D levels; and 6-month postoperative serum calcium and iPTH levels.

Results: A total of 304 patients had baseline iPTH values of at least 150 pg/mL (high baseline group), and 143 patients had baseline iPTH values lower than 150 pg/mL (low baseline group). Patients in the high baseline group had significantly higher levels of preoperative serum calcium, serum alkaline phosphatase, and parathyroid adenoma weights (P < .001 for all comparisons). Serum 25-hydroxyvitamin D levels were significantly lower in patients in the high baseline group (P < .001). Sestamibi scans were more likely to localize an adenoma in the high baseline group (83.7%) than in the low baseline group (68.9%) (P < .01). There were no differences in the serum calcium and iPTH levels between the 2 groups 6 months after surgery.

Conclusions: Patients in the high baseline group undergoing surgery for PHPT had higher baseline levels of serum calcium, serum alkaline phosphatase, and parathyroid adenoma weights and lower serum 25-hydroxyvitamin D levels compared with the lower baseline group. Sestamibi scans were more likely to localize an adenoma in the high baseline group (83.7%) than in the low baseline group (68.9%) (P < .01). Despite an apparently lower rate of positive preoperative sestamibi scans for the low baseline group, patients were able to achieve a similar rate of disease cure as other patients with higher baseline iPTH levels. It seems that baseline iPTH level should not be used as a criterion to perform surgery or not perform surgery for patients with PHPT.


Primary hyperparathyroidism (PHPT) is a common disorder characterized by chronically elevated serum calcium and serum intact parathyroid hormone (iPTH) concentrations and has an estimated incidence of 1 in every 500 women and 1 in every 2000 men older than 40 years. Intraoperative parathyroid (iOPTH) monitoring has facilitated more directed surgical approaches, smaller incisions, and shorter operative times in appropriately selected cases. The "50% rule," commonly attributed to George Irvin III, MD, has been used for defining biochemical cure intraoperatively but continues to be adjusted according to experience. These criteria were originally defined with clearly abnormal baseline iOPTH levels. However, the correct interpretation of iOPTH levels remains an understudied topic in relation to iPTH baseline levels.

As awareness of mild hyperparathyroidism has increased and indications for parathyroidectomy have been clarified and liberalized, patients are increasingly referred with biochemically subtle disease. Many patients are noted to have low baseline iPTH levels and mild indices of disease. Our goal in this study was to determine the relationship of iPTH baseline levels with severity of PHPT and outcomes of surgery. We hypothesized that baseline iPTH levels correlate with severity of PHPT and can predict the degree of a successful surgical outcome in patients undergoing surgery.
were compared using levels lower than 150 pg/mL (low baseline group), and the groups 150 pg/mL or higher (hereafter, high baseline group) and iPTH groups according to their baseline iPTH values; iPTH levels of sures were not normally distributed. Patients were divided into summarized with medians and ranges because many of the mea-
r primitives and percentages, and continuous data were
propriate descriptive statistics. Categorical data were summa-
ratory results, and IOPTH kinetics were summarized using ap-
plasia, and parathyroid carcinoma were not included in this
cluded calcium and iPTH levels at 1 week and 6 months fol-
tive sestamibi scans were reviewed. Treatment outcomes in-
review for excised parathyroid adenoma weights. Preopera-
phatase levels; and operative details. The pathology reports were
information; preoperative and baseline serum iPTH, serum cal-
ny; and operative measurement. Preop, preoperative measurement.
SI conversion factors: To convert alkaline phosphatase to microkatal per liter, multiply by 0.0167; to convert calcium to millimoles per liter, multiply by 0.25; to convert parathyroid hormone levels to nanograms per liter, multiply by 1. Analysis was performed using

### METHODS

This was a single institution retrospective review of a database of 447 consecutive patients who underwent parathyroidec-
tomy for PHPT from July 2002 to November 2006. Johns Hopkins institutional review board approval was obtained. Each pa-
ient’s medical record was reviewed for demographic information; preoperative and baseline serum iPTH, serum calcium, serum 25-hydroxyvitamin D, and serum alkaline phosphatase levels; and operative details. The pathology reports were
reviewed for excised parathyroid adenoma weights. Preopera-
tive sestamibi scans were reviewed. Treatment outcomes in-
cluded calcium and iPTH levels at 1 week and 6 months fol-
surgery. Patients with familial hyperparathyroidism (HPT), secondary and/or tertiary HPT, multiple endocrine neo-
plasia, and parathyroid carcinoma were not included in this study.

Demographic and clinical characteristics, preoperative lab-
ratory results, and IOPTH kinetics were summarized using ap-
propriate descriptive statistics. Categorical data were summa-
rized with frequencies and percentages, and continuous data were summarized with medians and ranges because many of the mea-
sures were not normally distributed. Patients were divided into 2
groups according to their baseline iPTH values; iPTH levels of 130 pg/mL or higher (hereinafter, high baseline group) and iPTH levels lower than 130 pg/mL (low baseline group), and the groups were compared using \chi^2 tests for categorical data and Wilcoxon rank sum tests for continuous data. (To convert PTH levels to nanograms per liter, multiply by 1.) Analysis was performed using SAS statistical software (version 9.1.3; SAS Institute Inc, Cary, North Carolina). All reported \(P\) values are 2-sided, and \(P < .05\) was considered significant.

### RESULTS

A total of 447 consecutive patients were included in the study. The median age of the patients was 61 years (range,

### Table. Clinical Characteristics of the Study Population by Low and High Baseline iPTH Levels

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Low Baseline (n=304)</th>
<th>High Baseline (n=143)</th>
<th>(P) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenoma weight, mg</td>
<td>415 (15 to 6100)</td>
<td>910 (60 to 3300)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>25-hydroxyvitamin D level, ng/dL</td>
<td>18 (4 to 78)</td>
<td>16 (4 to 49)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&lt;25 ng/dL</td>
<td>133 (53.6)</td>
<td>89 (79.5)</td>
<td></td>
</tr>
<tr>
<td>(\geq 25) ng/dL</td>
<td>115 (46.4)</td>
<td>23 (20.5)</td>
<td></td>
</tr>
<tr>
<td>Alkaline phosphatase level, U/L</td>
<td>87 (28 to 244)</td>
<td>104 (45 to 329)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Calcium level, preop, mg/dL</td>
<td>11.0 (8.5 to 12.7)</td>
<td>11.4 (9.4 to 14.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>iPTH level, preop, pg/mL</td>
<td>100 (16 to 149)</td>
<td>197 (150 to 1023)</td>
<td>&lt;.001</td>
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<td>Sestamibi scans</td>
<td></td>
<td></td>
<td>.001</td>
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<tr>
<td>Positive for adenoma</td>
<td>204 (68.9)</td>
<td>118 (83.7)</td>
<td></td>
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<tr>
<td>Nonpositive</td>
<td>92 (31.1)</td>
<td>26 (16.3)</td>
<td></td>
</tr>
<tr>
<td>iPTH level change, after 5 min, %</td>
<td>63.2 (~178.5 to 92.3)</td>
<td>70.7 (~246.4 to 96.5)</td>
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<td>iPTH level, after 10 min, pg/mL</td>
<td>16 (5 to 200)</td>
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<td>iPTH level change, after 10 min, %</td>
<td>82.0 (~700.0 to 95.9)</td>
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<tr>
<td>Calcium level, 6-mo postop, mg/dL</td>
<td>9.6 (8.6 to 10.8)</td>
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<td>.46</td>
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<tr>
<td>iPTH level, 6-mo postop, pg/mL</td>
<td>39 (5.7 to 129)</td>
<td>46 (6.6 to 167)</td>
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**Abbreviations:** IOPTH, intraoperative parathyroid hormone; iPTH, intact parathyroid hormone; postop, postoperative measurement; preop, preoperative measurement.

### COMMENT

Primary hyperparathyroidism, once the disease of “bones, stones, abdominal groans, and psychic over-
tones,” has become largely a biochemical disorder in the asymptomatic or mildly symptomatic patient. Although operative excision of the offending gland or glands is mandatory in symptomatic patients, the ben-
efit of surgery in certain asymptomatic patients has been debated.8,9 Intraoperative PTH monitoring with preoperative localization studies has enabled success rates as high as 98% with minimally invasive parathyroidectomy for PHPT.10 Multiple studies have shown

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**Abstract:** This was a single institution retrospective review of a database of 447 consecutive patients who underwent parathyroidectomy for primary hyperparathyroidism (PHPT). The demographic characteristics, preoperative laboratory results, and IOPTH kinetics for both groups are shown in the Table. Patients in the high baseline group had significantly higher levels of preoperative serum calcium, serum alkaline phosphatase, and adenoma weights and significantly lower levels of serum 25-hydroxyvitamin D (Figure 1) (P < .001 for all comparisons). Median baseline iPTH and IOPTH levels taken at 5 and 10 minutes after resection are shown by baseline iPTH group in Figure 2. Sestamibi scans were positive for adenoma more often in the high baseline group (83.7%) than in the low baseline group (68.9%) (P < .01). There was no difference in the calcium and iPTH levels between the 2 groups 6 months after surgery.

**Key Words:** primary hyperparathyroidism; parathyroidectomy; intraoperative PTH monitoring; parathyroid carcinoma; familial hyperparathyroidism

**Funding:** No external funding was received for this study.

**Conflict of Interest:** None.

**Author Disclosure:** None.

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Our current study found a positive association between baseline iPTH levels and adenoma weight. In addition, our study demonstrated that patients in the high baseline group had more advanced indices of PHPT. Median preoperative serum calcium levels were significantly higher ($P < .001$) in the high baseline group. Patients in the high baseline group also had higher serum alkaline phosphatase activity, reflecting the increased severity of bone turnover. The 25-hydroxyvitamin D levels were significantly lower in patients in the high baseline group. The cause of these findings is uncertain but likely multifactorial. Despite these findings, there was no significant difference between the 2 groups when comparing the serum calcium ($P = .46$) and iPTH ($P = .09$) values measured 6 months after surgery. While baseline iPTH may correlate with severity of PHPT based on the disease parameters we analyzed, it does not distinguish the cure rate between the 2 groups based on serum calcium and iPTH levels measured 6 months after surgery. Although the clinical relevance of our study should be validated by additional prospective studies, we believe that patients with low baseline PTH levels are likely to achieve a similar cure rate, with serum calcium and iPTH levels similar to those of the high baseline group at 6 months after surgery that may further justify surgical intervention.

In conclusion, patients in the high baseline group had higher levels of serum calcium, serum alkaline phosphatase, and parathyroid adenoma weights and lower serum 25-hydroxyvitamin D levels compared with the low baseline group. Sestamibi scans were more likely to localize an adenoma in the high baseline group (83.7%) than the low baseline group (68.9%) ($P < .01$). Despite an apparently lower rate of positive preoperative sestamibi scans for the low baseline group, patients were able to achieve serum calcium and iPTH levels 6 months after surgery that were similar to those of other patients undergoing surgery in the high baseline group.
It seems that baseline iPTH is not helpful in predicting cure from surgery and should not be used as a criterion to perform surgery or not perform surgery for patients with PHPT.

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Author Contributions: All authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Kandil and Tufano. Acquisition of data: Kandil. Analysis and interpretation of data: Kandil, Alabbas, Tufaro, Carson, and Tufano. Drafting of the manuscript: Kandil, Alabbas, and Carson. Critical revision of the manuscript for important intellectual content: Tufaro and Tufano. Statistical analysis: Carson. Administrative, technical, and material support: Kandil and Alabbas. Study supervision: Kandil and Tufano.

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REFERENCES