Original Article

Cukurova Anestezi ve Cerrahi Bilimler Dergisi

Selective Use of Intraoperative Gamma Probe in Parathyroidectomy: A Single-Center Retrospective Study

Mahmut Baran Yerlikaya[1], *Adem Aslan*[1], *Harun Bayram*[1]

[1] Department of General Surgery, Faculty of Medicine, Ağrı İbrahim Çeçen University, Ağrı, Türkiye

***Correspondence:** Baran Yerlikaya, MD; gcbaranyerlikaya@gmail.com

Abstract

Objective: Radioguided parathyroidectomy using a handheld gamma probe may facilitate intraoperative gland localization; however, its incremental value in routine primary hyperparathyroidism (pHPT) surgery remains controversial, particularly in resource-limited settings. This study evaluated perioperative and early biochemical outcomes of selective intraoperative gamma probe use during parathyroidectomy in a single-center cohort. **Methods:** This retrospective observational study included 50 consecutive patients who underwent parathyroid surgery between January 2024 and December 2025. Preoperative localization was performed using cervical ultrasonography with or without sestamibi scintigraphy. Gamma probe guidance was selectively utilized in patients with discordant, equivocal, or technically challenging localization findings. Operative outcomes, postoperative hypocalcemia, and early biochemical response were compared between patients with and without gamma probe use. **Results:** Gamma probe guidance was used in 14 of 50 patients (28%). Mean operative time did not differ significantly between groups (46.1±2.9 vs 44.4±6.7 min; p=0.239). Patients undergoing gamma probe-assisted surgery demonstrated lower preoperative calcium and PTH levels despite increased localization complexity. Transient hypocalcemia occurred only in the non–gamma probe group (22.2% vs 0.0%; p=0.087), whereas no permanent hypocalcemia was observed. Percent postoperative PTH reduction was significantly lower in the gamma probe group (85.2% vs 90.5%; p=0.006). **Conclusion:** Selective intraoperative gamma probe use during parathyroidectomy was not associated with reduced operative time and appeared to be preferentially utilized in patients with localization-related surgical complexity rather than more severe biochemical disease. These findings suggest that selective rather than routine gamma probe implementation may represent a pragmatic strategy in appropriately selected patients. Larger prospective studies are needed to better define the patient subgroups most likely to benefit from radioguided surgery.

Keywords: Primary hyperparathyroidism, parathyroidectomy, radioguided surgery, gamma probe, sestamibi scintigraphy, preoperative localization

Received: 15.01.2026

Accepted: 09.06.2026

Published: 30.06.2026

1. Introduction

Parathyroidectomy is the definitive treatment for primary hyperparathyroidism (pHPT) and achieves high cure rates when performed by experienced surgeons. Over the past decades, focused (minimally invasive) approaches have expanded, supported by

preoperative localization imaging and adjuncts such as intraoperative parathyroid hormone (ioPTH) monitoring and radioguidance with handheld gamma probes. The American Association of Endocrine Surgeons (AAES) guideline emphasizes that adjuncts should be tailored to disease context and surgeon experience, noting the value of ioPTH, particularly in reoperative settings and focused operations[1]. In addition, meta-analytic evidence has demonstrated that intraoperative PTH monitoring may improve cure rates and reduce reoperation rates in minimally invasive parathyroidectomy, particularly in cases with uncertain localization or multigland disease[2]. Radioguided parathyroidectomy has been reported to facilitate localization and confirm tissue excision using intraoperative counts, with large series demonstrating high eucalcemia rates[3,4]. However, the incremental benefit of routine gamma probe use in standard pHPT surgery is not universal, and many centers—especially those with resource constraints—apply radioguidance selectively.

Preoperative imaging strongly influences the feasibility of focused exploration. Evidence from district general hospitals suggests that combined ultrasound and sestamibi scintigraphy improves localization accuracy and supports focused surgery, while SPECT/CT-based localization strategies may further improve operative planning in selected patients with inconclusive imaging findings[5,6]. Nevertheless, discordant or equivocal localization studies remain a significant challenge in daily surgical practice and may necessitate adjunctive intraoperative techniques despite relatively mild biochemical disease profiles. In such patients, technological support may be required primarily because of localization difficulty rather than disease severity itself. In this context, understanding when radioguidance adds measurable value is clinically relevant. We therefore evaluated outcomes of parathyroidectomy performed with selective gamma probe use in a single-center cohort, focusing on operative metrics, early biochemical response, and postoperative hypocalcemia.

2. Materials and Methods

2.1. Study Design and Patients

This retrospective observational study included consecutive adult patients who underwent parathyroid surgery between January 2024 and December 2025 at a regional general surgery unit. Patients were evaluated for suspected primary hyperparathyroidism based on clinical, biochemical, and imaging findings. The dataset comprised 50 operations.

2.2. Preoperative Localization

Cervical ultrasound was performed in all patients, with sestamibi scintigraphy added in selected cases (e.g., inconclusive ultrasound or suspected ectopic gland). Gamma probe guidance was selectively used in cases with discordant or equivocal preoperative localization, suspected ectopic glands, or anticipated difficult exploration. Patients selected for gamma probe use generally represented cases with localization difficulty rather than advanced biochemical disease severity.

2.3. Perioperative Management and Outcomes

Outcomes extracted from the clinical records included operative time (minutes), length of stay (hours), drain use, and postoperative hypocalcemia. Transient hypocalcemia was defined as postoperative biochemical and/or clinical hypocalcemia requiring calcium supplementation with subsequent resolution, whereas permanent hypocalcemia was defined as persistent hypocalcemia during follow-up. Early biochemical response was assessed by the percent reduction in intact PTH from baseline to postoperative PTH measurement.

During the later phase of the study period, gamma probe guidance was gradually introduced into institutional practice. Simultaneously, a standardized 36-hour postoperative observation and discharge protocol was implemented for patients undergoing gamma probe-assisted surgery. Therefore, comparisons regarding length of stay should be interpreted cautiously, as postoperative management pathways differed between groups.

2.4. Statistical Analysis

Continuous variables are reported as mean ± standard deviation and compared using Welch's t-test. Categorical variables are reported as counts and percentages and compared using Fisher's exact test. Two-sided p-values <0.05 were considered statistically significant. Additional regression analyses were performed incorporating baseline variables, including age, preoperative calcium level, preoperative PTH level, adenoma size, and imaging modality, as covariates.

2.5. Ethics Committee Approval

This study was reviewed and approved by the Scientific Research Ethics Committee of Ağrı İbrahim Çeçen University (Approval date: 25 December 2025; Decision No: 576). Given the retrospective nature of the study, ethical approval covered retrospective review of previously recorded clinical data.

3. Results

Patient characteristics are summarized in Table 1. The cohort included 50 patients (female 41, 82%). Gamma probe guidance was used in 14/50 cases (28%). Preoperative localization consisted of ultrasound alone in 24 cases and ultrasound plus scintigraphy in 26 cases. A representative focused parathyroidectomy specimen obtained during surgery is presented in Figure 1.

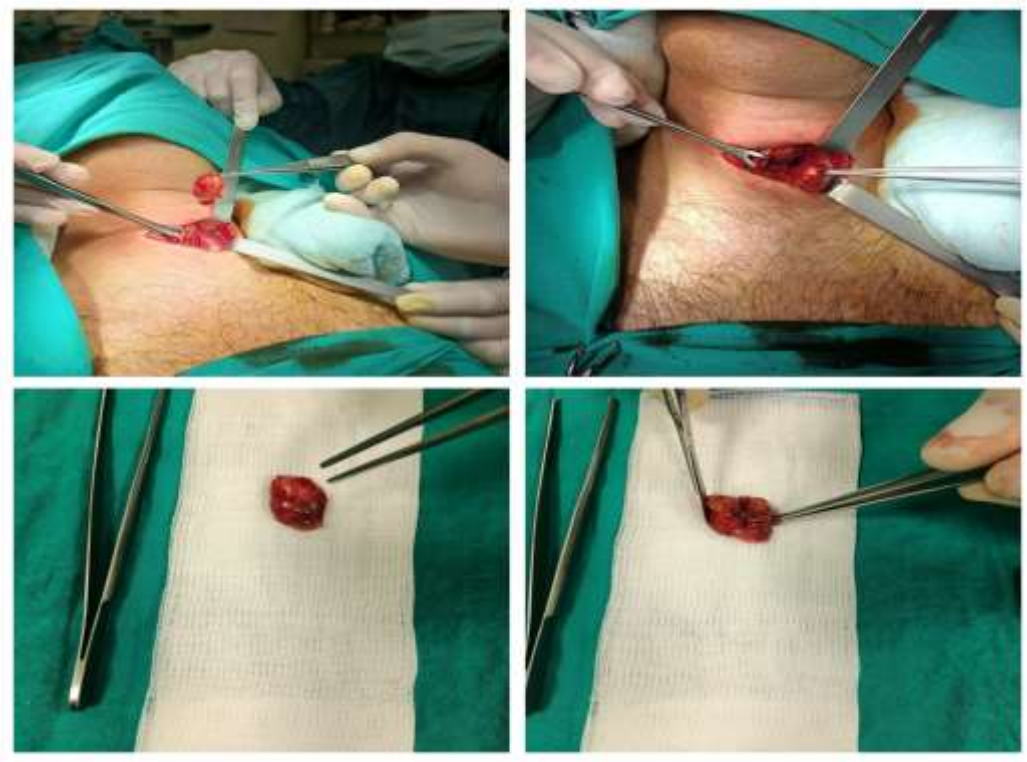

Figure 1. Intraoperative view of focused parathyroidectomy demonstrating the excised parathyroid adenoma

Patients in the gamma probe group had significantly lower preoperative calcium and PTH levels compared with the non–gamma probe group (both p<0.001). Despite this relatively milder biochemical profile, these patients more frequently demonstrated discordant, equivocal, or technically challenging localization findings requiring adjunctive intraoperative guidance.

Adenoma size demonstrated substantial variability in the gamma probe group (1.69 ± 2.11 cm). This dispersion was primarily related to a limited number of patients with unusually large adenomas, resulting in a wider standard deviation despite a comparable mean adenoma size between groups.

Table 1. Baseline demographic, biochemical, and localization characteristics according to intraoperative gamma probe use

Variable	No gamma probe (n=36)	Gamma probe (n=14)	p-value
Age (years)	54.56 ± 7.14	54.86 ± 6.60	0.888
Female sex, n (%)	29 (80.6)	12 (85.7)	1.000
Preoperative calcium (mg/dL)	11.01 ± 0.35	10.45 ± 0.25	<0.001
Preoperative PTH (pg/mL)	438.56 ± 133.64	229.86 ± 37.05	<0.001
Adenoma size (cm)	1.79 ± 0.29	1.69 ± 2.11	0.858
USG + sestamibi scintigraphy, n (%)	12 (33.3)	14 (100.0)	0.001

Values are mean ± SD or n (%). Welch's t-test or Fisher's exact test.

Operative outcomes are shown in Table 2. Mean operative time did not differ significantly between groups (44.44 ± 6.74 vs 46.07 ± 2.89 min; p=0.239). Mean length of stay differed significantly between groups (42.67 ± 13.59 vs 36.00 ± 0.00 hours; p=0.006). Drain placement occurred in 14 patients (28%).

Biochemical and safety outcomes are summarized in Table 3. Transient hypocalcemia occurred in 8 patients (16%), all in the non–gamma probe group (22.2% vs 0.0%; p=0.087), whereas no permanent hypocalcemia was observed. Percent PTH reduction was significantly lower in the gamma probe group (90.45 ± 5.38 vs 85.19 ± 5.61; p=0.006). Postoperative 32-hour calcium levels were significantly higher in the gamma probe group (8.53 ± 0.73 vs 8.85 ± 0.20 mg/dL; p=0.019).

Additional regression analyses incorporating baseline covariates demonstrated that gamma probe use was not independently associated with operative time reduction after adjustment for baseline differences.

Table 2. Operative and perioperative outcomes according to intraoperative gamma probe use

Outcome	No gamma probe (n=36)	Gamma probe (n=14)	p-value
Operative time (minutes)	44.44 ± 6.74	46.07 ± 2.89	0.239
Length of stay (hours)	42.67 ± 13.59	36.00 ± 0.00	0.006
Drain placement, n (%)	8 (22.9)	6 (42.9)	0.173

Values are mean ± SD or n (%). Welch's t-test or Fisher's exact test.

Table 3. Early postoperative biochemical outcomes and hypocalcemia according to intraoperative gamma probe use

Outcome	No gamma probe (n=36)	Gamma probe (n=14)	p-value
Postoperative PTH (pg/mL)	37.03 ± 14.42	33.43 ± 12.31	0.385
Postoperative 32-hour calcium (mg/dL)	8.53 ± 0.73	8.85 ± 0.20	0.019
Postoperative PTH reduction (%)	90.45 ± 5.38	85.19 ± 5.61	0.006
Transient hypocalcemia, n (%)	8 (22.2)	0 (0.0)	0.087
Permanent hypocalcemia, n (%)	0 (0.0)	0 (0.0)	1.000

Values are mean ± SD or n (%). Welch's t-test or Fisher's exact test.

4. Discussion

This study presents a real-world experience with selective intraoperative gamma probe use during parathyroidectomy in patients with primary hyperparathyroidism. Although radioguided surgery is conceptually attractive because it may facilitate intraoperative localization and confirmation of excised hyperfunctioning tissue, its routine use remains controversial in standard primary hyperparathyroidism surgery. In our cohort, gamma probe use was not associated with shorter operative time despite selective implementation in technically challenging cases. This finding suggests that the potential procedural advantages of radioguidance may have been counterbalanced by underlying localization difficulty and case complexity. Similar studies evaluating adjunctive localization techniques have also emphasized the importance of institutional experience and multimodal localization strategies in optimizing surgical success[7,8,9].

Several contemporary studies have similarly demonstrated that minimally invasive parathyroidectomy outcomes are highly dependent on concordant preoperative localization and institutional surgical expertise rather than on the routine use of a single adjunctive technology alone[10,11].

An important finding of the present study is that patients requiring gamma probe assistance generally exhibited relatively milder biochemical disease profiles despite increased localization complexity. This apparent discrepancy likely reflects the fact that selective radioguidance was primarily used in patients with discordant, equivocal, or technically difficult imaging findings rather than in patients with more severe biochemical hyperparathyroidism. Therefore, the indication for gamma probe utilization in our cohort appeared to be driven predominantly by localization uncertainty rather than disease burden itself. Recent literature has also emphasized that imaging discordance may persist even in patients with relatively limited biochemical disease activity, further supporting the selective use of adjunctive intraoperative localization techniques in carefully selected patients[12].

The role of adjunctive intraoperative technologies in minimally invasive parathyroidectomy has been increasingly emphasized in recent years. Although gamma probe guidance differs mechanistically from intraoperative PTH monitoring, both approaches share the common objective of improving intraoperative decision-making under conditions of localization uncertainty. Selective adjunctive technology use may therefore optimize operative efficiency while avoiding unnecessary resource utilization in straightforward cases with concordant localization studies[13].

Transient hypocalcemia occurred exclusively in the non–gamma probe group, although this difference did not reach statistical significance. Because of the relatively small sample size and limited event number, the present study was likely underpowered to detect small but potentially clinically meaningful differences in postoperative hypocalcemia rates. Importantly, no permanent hypocalcemia was observed in either group, supporting the overall safety of the surgical approach. Previous studies evaluating postoperative calcium dynamics after minimally invasive parathyroidectomy have similarly emphasized that transient biochemical hypocalcemia may occur even in technically successful operations[14].

The significantly shorter length of stay observed in the gamma probe group should also be interpreted cautiously. This difference primarily reflected the implementation of a standardized 36-hour postoperative observation and discharge protocol introduced during the later phase of the study period, rather than a direct effect of gamma probe use itself.

From a broader health systems perspective, our findings suggest that selective gamma probe implementation may be a feasible and pragmatic approach in centers where routine radioguided surgery is not consistently available. Future prospective multicenter

studies are needed to identify patient subgroups most likely to derive measurable benefit from radioguidance. Future technological developments, including image-guided navigation systems and fluorescence-assisted localization techniques, may further refine focused parathyroid surgery[15].

4.1. Limitations

Limitations of the present study include its retrospective design, single-center setting, and relatively limited sample size, which reduce statistical power for uncommon outcomes. Gamma probe utilization was not randomized and likely reflected surgeon-driven case selection based on localization difficulty. Although additional regression analyses were performed to reduce potential selection bias, residual confounding cannot be completely excluded. Follow-up primarily focused on early biochemical response; long-term eucalcemia and recurrence rates could not be comprehensively evaluated. The observed difference in length of stay should be interpreted cautiously due to the introduction of a standardized discharge protocol during the study period.

5. Conclusion

Selective intraoperative gamma probe use during parathyroidectomy was not associated with shorter operative time in this single-center retrospective cohort. Gamma probe guidance appeared to be preferentially utilized in patients with localization-related surgical complexity rather than in patients with more severe biochemical disease. Overall surgical outcomes were favorable, with robust early biochemical response and no cases of permanent hypocalcemia. Our findings suggest that selective rather than routine implementation of gamma probe guidance may represent a pragmatic and resource-conscious strategy in appropriately selected patients. Larger prospective multicenter studies incorporating standardized perioperative protocols and long-term follow-up are needed to better define the patient subgroups most likely to derive measurable benefit from radioguided parathyroid surgery.

Author Contributions: Concept and design: M.B.Y.; Data collection: M.B.Y., A.A., H.B.; Data analysis and interpretation: M.B.Y.; Manuscript drafting and critical revision: M.B.Y., A.A., H.B.

Conflict of Interest: The authors declare no conflict of interest.

Financial Disclosure: This study received no financial support.

Ethics Committee Approval: This study was reviewed and approved by the Scientific Research Ethics Committee of Ağrı İbrahim Çeçen University (Approval date: 25 December 2025; Decision No: 576).

References

1. Wilhelm SM, Wang TS, Ruan DT, Lee JA, Asa SL, Duh QY, et al. The American Association of Endocrine Surgeons guidelines for definitive management of primary hyperparathyroidism. *JAMA Surg.* 2016;151(10):959-968.
2. Quinn AJ, Ryan ÉJ, Garry S, James DL, Boland MR, Young O, et al. Use of intraoperative parathyroid hormone in minimally invasive parathyroidectomy for primary hyperparathyroidism: a systematic review and meta-analysis. *JAMA Otolaryngol Head Neck Surg.* 2021;147(2):135-143.
3. Chen H, Mack E, Starling JR. Radioguided parathyroidectomy is equally effective for both adenomatous and hyperplastic glands. *Ann Surg.* 2003;238(3):332-338.

4. Chen H, Sippel RS, Schaefer S. The effectiveness of radioguided parathyroidectomy in patients with negative technetium Tc 99m-sestamibi scans. *Arch Surg.* 2009;144(7):643-648.
5. Scattergood S, Marsden M, Kyrimi E, Ishii H, Doddi S, Sinha P. Combined ultrasound and sestamibi scintigraphy provides accurate preoperative localisation for patients with primary hyperparathyroidism. *Ann R Coll Surg Engl.* 2019;101(2):97-102.
6. Patel CN, Salahudeen HM, Lansdown M, Scarsbrook AF. Clinical utility of ultrasound and 99mTc sestamibi SPECT/CT for preoperative localization of parathyroid adenoma in patients with primary hyperparathyroidism. *Clin Radiol.* 2010;65(4):278-287.
7. Erdemir RU, Taşdöven I, Bayraktaroğlu T, Çakmak GK. Intraoperative ultrasound imaging and sono-scintigraphic concordance improves success rates of minimally invasive parathyroidectomy. *Turk J Med Sci.* 2021;51(5):2341-2345.
8. Akgün IE, Ünlü MT, Aygun N, Kostek M, Uludag M. Contribution of intraoperative parathyroid hormone monitoring to the surgical success in minimally invasive parathyroidectomy. *Front Surg.* 2022;9:1024350.
9. Noureldine SI, Gooi Z, Tufano RP. Minimally invasive parathyroid surgery. *Gland Surg.* 2015;4(5):410-419.
10. Udelsman R, Lin Z, Donovan P. The superiority of minimally invasive parathyroidectomy based on 1650 consecutive patients with primary hyperparathyroidism. *Ann Surg.* 2011;253(3):585-591.
11. Mihai R, Barczynski M, Iacobone M, Sitges-Serra A. Surgical strategy for sporadic primary hyperparathyroidism: an evidence-based approach to surgical strategy, patient selection, surgical access, and reoperations. *Langenbecks Arch Surg.* 2009;394(5):785-798.
12. Cheung K, Wang TS, Farrokhyar F, Roman SA, Sosa JA. A meta-analysis of preoperative localization techniques for patients with primary hyperparathyroidism. *Ann Surg Oncol.* 2012;19(2):577-583.
13. Bergenfelz A, Lindblom P, Tibblin S, Westerdahl J. Unilateral versus bilateral neck exploration for primary hyperparathyroidism: a prospective randomized controlled trial. *Ann Surg.* 2002;236(5):543-551.
14. Cayo AK, Yen TW, Misustin SM, Wall K, Wilson SD, Evans DB, Wang TS. Predicting the need for calcium and calcitriol supplementation after total thyroidectomy: results of a prospective, randomized study. *Surgery.* 2012;152(6):1059-1067.
15. Wang B, Zhu CR, Liu H, Yao XM, Wu J. The accuracy of near infrared autofluorescence in identifying parathyroid gland during thyroid and parathyroid surgery: a meta-analysis. *Front Endocrinol (Lausanne).* 2021;12:701253.