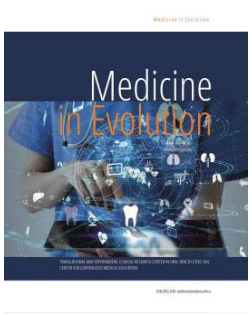
Unilateral Focused Parathyroidectomy versus Bilateral Neck Exploration in Primary Hyperparathyroidism: A Retrospective Cohort Study



https://doi.org/10.70921/medev.v32i1.2028

Adina Coman[1,2], Daian Ionel Popa[1], Diana Utu[3], Florina Buleu[4], Mihaela Avram[2,5], Marius Murariu[2,5]

[1]Doctoral School, Victor Babes University of Medicine and Pharmacy Timisoara, E. Murgu Square, No. 2,300041 Timisoara, Romania;
[2]Department X, Discipline of General Surgery I, Faculty of Medicine, Victor Babes University of Medicine and Pharmacy Timisoara, E. Murgu Square, No. 2, 300041 Timisoara, Romania;
[3]Department II, Discipline of Pharmacology-Pharmacotherapy, Faculty of Pharmacy, Victor Babes University of Medicine and Pharmacy Timisoara, E. Murgu Square, No. 2, 300041 Timisoara, Romania;
[4]Department VI, Discipline of Internal Medicine and Ambulatory Care, Prevention and Cardiovascular Recovery, Faculty of Medicine, Victor Babes University of Medicine and Pharmacy Timisoara, E. Murgu Square, No. 2, 300041 Timisoara, Romania;
[5]Center for Research in Abdominal Surgery and Flebology – CCCAF, UMF Victor Babes Timisoara

Correspondence to:
Name: Mihaeala Avram
E-mail address: avram,mihaela@umft.ro

Received: 23 February 2026; Accepted: 11 March 2026; Published: 31 March 2026

Abstract

1.Background: Primary hyperparathyroidism (pHPT) is cured by parathyroidectomy. Bilateral neck exploration (BNE) has been the historical standard, whereas improved preoperative imaging and intraoperative parathyroid hormone (IOPTH) monitoring support unilateral focused parathyroidectomy (UFP) in selected patients. This study compared UFP and BNE. *2.Methods:* We conducted a single-center retrospective cohort study of adults undergoing initial surgery for sporadic pHPT between 2012 and 2023 with ≥6 months follow-up. Diagnosis was biochemical (hypercalcemia with inappropriately high/unsuppressed PTH). Localization used cervical ultrasound and technetium-99m sestamibi; IOPTH was used when available to confirm adequate resection and prompt conversion to wider exploration if needed. *3.Results*: Of 84 operated patients, 72 met inclusion criteria (mean age 51.9±14.1 years; 77.8% female). UFP was performed as the first operation in 54 patients (75%) and BNE in 18 (25%). Pathology revealed single adenoma in 66 cases (91.7%), multiple adenomas in 3 (4.2%), and hyperplasia in 3 (4.2%). Eight patients (11.1%) required reoperation, and persistent disease without further surgery occurred in 2 (2.8%). One patient later developed parathyroid carcinoma with bone metastasis and died. No significant differences at 6 months follow-up between the two procedures. *4.Conclusions:* In a cohort largely characterized by single-gland disease, UFP was the predominant approach with low clinical recurrence; BNE remained essential for non-localizing or complex disease.

Keywords: Primary hyperparathyroidism, Unilateral focused parathyroidectomy, Bilateral neck exploration, Intraoperative parathyroid hormone (IOPTH) monitoring, Parathyroid adenoma

INTRODUCTION

Primary hyperparathyroidism (pHPT) is a common endocrine disorder in which excessive parathyroid hormone causes hypercalcemia. If left untreated, this may lead to nephrolithiasis, osteoporosis, and fragility fractures, with variable neurocognitive and gastrointestinal manifestations. Parathyroidectomy is the only definitive cure and is recommended for symptomatic patients and for selected asymptomatic patients meeting established guideline criteria [1-5]. For decades, the standard surgical treatment for pHPT has been a bilateral neck exploration (BNE). In a traditional BNE, a cervical incision is used to identify all four parathyroid glands and excise abnormal tissue. This comprehensive approach achieves very high initial cure rates in experienced hands and reduces the likelihood of missing multigland disease, but it requires broader dissection and may increase operative duration and the risk of transient hypocalcemia or recurrent laryngeal nerve injury compared with more limited approaches. [6-8]

In the last two decades, advances in preoperative localization and intraoperative monitoring have enabled a focused, minimally invasive surgical approach for many patients. High-resolution ultrasound and sestamibi-based imaging can localize a dominant hyperfunctioning gland, while rapid intraoperative parathyroid hormone (IOPTH) assays allow biochemical confirmation of adequate resection by demonstrating an appropriate decline in PTH during the operation. Together, these developments support unilateral focused parathyroidectomy targeted at the suspected lesion, avoiding routine four-gland exploration when it is unlikely to add value [9-12].

A unilateral focused approach offers advantages in appropriately selected cases. By limiting dissection to one side, the procedure can shorten operative time, reduce tissue trauma, and facilitate faster recovery, often allowing short hospital stays. Limiting exploration may also reduce the risk of postoperative hypocalcemia and bilateral nerve injury. When a solitary adenoma is the cause of pHPT, focused surgery can achieve cure rates comparable to BNE, and contemporary series and meta-analyses support its effectiveness when localization is concordant and surgical expertise is available. Recent single-center experiences have similarly reported high cure rates with selective use of focused exploration alongside BNE for complex presentations [2,3,9,13-18].

However, focused parathyroidectomy is not appropriate for every case. A clinically important minority of patients have multigland disease (multiple adenomas or parathyroid hyperplasia), and limited exploration may fail if additional hyperfunctioning tissue is left in situ. Accordingly, when preoperative imaging is negative or discordant, when intraoperative findings are inconsistent with a single-gland process, or when PTH fails to decline appropriately after targeted excision, surgeons often proceed with BNE to ensure that all hyperfunctioning tissue is addressed. These trade-offs underpin an ongoing debate about the optimal extent of exploration in routine pHPT surgery [2,3,9,12,13].

In light of these considerations, we conducted a single-center retrospective cohort study to compare the two surgical approaches for pHPT. The objective was to evaluate and contrast the outcomes of unilateral focused parathyroidectomy versus bilateral neck exploration in patients with primary hyperparathyroidism – specifically examining cure rates, disease recurrence, and complications – in order to inform optimal surgical management of this condition.

Aim and objectives

In light of these considerations, we conducted a single-center retrospective cohort study to compare the two surgical approaches for pHPT. The objective was to evaluate and

contrast the outcomes of unilateral focused parathyroidectomy versus bilateral neck exploration in patients with primary hyperparathyroidism – specifically examining cure rates, disease recurrence, and complications – in order to inform optimal surgical management of this condition.

MATERIAL AND METHODS

This study is a retrospective cohort analysis conducted at a single tertiary care academic hospital. We reviewed the medical records of all patients who underwent parathyroidectomy for primary hyperparathyroidism (pHPT) between January 2012 and December 2023. The study obtained approval from the institutional ethics committee, with a waiver of individual consent due to its retrospective design. Multiple endocrine surgeons at the centre performed the operations over the study period. All available perioperative and follow-up data were collected, including patient demographics, clinical presentation, laboratory results, imaging findings, surgical details, and pathology reports.

Inclusion and Exclusion Criteria

Inclusion criteria were defined to capture patients with sporadic pHPT undergoing curative surgery: adult patients (age ≥18) with biochemically confirmed primary hyperparathyroidism who underwent initial parathyroidectomy at our institution during the study period. Exclusion: no postoperative follow-up of at least 6 months to ensure outcome assessment.

Preoperative Evaluation

All patients underwent a standardized preoperative evaluation by an endocrinologist and a surgeon. The diagnosis of primary hyperparathyroidism was confirmed biochemically by the finding of elevated serum calcium levels in conjunction with inappropriately high or unsuppressed intact parathyroid hormone (PTH) concentrations. Additional laboratory assessments included serum phosphate, 25-hydroxyvitamin D, and creatinine to assess kidney function. Patients with very low vitamin D levels were repleted prior to surgery, in order to minimize post-parathyroidectomy hypocalcemia risk. The presence of end-organ effects of pHPT was documented, including a history of nephrolithiasis, osteoporosis or fragility fractures, and neurocognitive or gastrointestinal symptoms [1-5].

Indications for surgery followed contemporary consensus guidelines for pHPT. All symptomatic patients (e.g. those with kidney stones, bone disease, or significant hypercalcemic symptoms) were offered surgery. Asymptomatic patients were considered surgical candidates if they met at least one guideline criterion, such as: serum calcium more than 1.0 mg/dL above the upper normal limit, reduced bone mineral density (T-score ≤ –2.5 or prior fragility fracture), evidence of nephrolithiasis/nephrocalcinosis, impaired renal function (glomerular filtration rate < 60 mL/min), or age under 50 years. These criteria ensured that all patients had a clear indication for parathyroidectomy [4,5].

Preoperative localization studies were obtained for all patients to guide the surgical approach. High-resolution cervical ultrasound was performed to identify enlarged parathyroid glands and evaluate thyroid pathology. In addition, to some cases a technetium-99m sestamibi scintigraphy was conducted to localize hyperfunctioning parathyroid tissue. All patients were assessed to be fit for surgery, and any coexisting medical conditions (such as hypertension or cardiac issues) were optimized preoperatively [9-11,19,20].

Surgical Technique

All parathyroidectomies were performed under general anesthesia with endotracheal intubation. Patients were positioned with neck extension, and a sterile low transverse cervical incision (approximately 3–4 cm, along a skin crease) was utilized in all cases. In each operation, the surgeon identified and preserved the recurrent laryngeal nerve on the side of

exploration and took care to maintain intact parathyroid blood supply for any glands left in situ. A rapid intraoperative PTH (IOPTH) assay was employed in every case to guide the extent of resection whenever available at the hospital laboratory. Baseline PTH levels were drawn after induction of anesthesia (prior to incision), and subsequent samples were obtained 5 and 10 minutes after removal of suspected abnormal parathyroid tissue. The criterion for biochemical cure during surgery was a drop in IOPTH level of ≥50% from the pre-excision baseline and into the normal PTH reference range by 10 minutes post-excision (Miami criterion). If this criterion was met, it indicated that all hyperfunctioning tissue had likely been removed [9,12].

Unilateral focused parathyroidectomy: patients with preoperative imaging localizing a single parathyroid adenoma underwent a unilateral focused parathyroidectomy. In these cases, the operation was targeted to the region of the identified abnormal gland (typically one side of the neck). Intraoperative frozen-section pathology was occasionally utilized to confirm that the resected tissue was indeed parathyroid gland. After removal, IOPTH levels were checked as described if available (due to availability at the hospital laboratory). If the PTH dropped appropriately (≥50% and into normal range), no further gland exploration was performed. The wound was then closed without routine drain placement, and the patient was observed for the standard postoperative period. This focused approach minimized dissection and operative time while achieving cure in patients with single-gland disease [9,12].

Bilateral neck exploration: If preoperative imaging was negative, if it suggested multiglandular disease, or if the intraoperative findings/IOPTH results did not meet cure criteria after a focused resection, a bilateral neck exploration (BNE) was undertaken. In a planned BNE, the incision was typically slightly longer to allow access to both sides of the neck. The surgeon systematically identified all four parathyroid glands. Any grossly enlarged or abnormal-appearing glands were resected. In patients with multigland hyperplasia (suspected when more than one gland appeared enlarged or hormone levels failed to drop after a single adenoma removal), a subtotal parathyroidectomy was performed: usually three and a half glands were removed, leaving a small remnant of the most normal-appearing gland in situ to prevent permanent hypoparathyroidism. Alternatively, in a few cases of multigland disease, one entire gland was left in situ or a portion of a gland was autotransplanted into a forearm or sternocleidomastoid muscle, according to surgeon preference. All resected specimens were sent for histopathological examination to confirm the presence of parathyroid adenoma or hyperplasia and to rule out rare parathyroid carcinoma. Postoperatively, all patients received standard care including calcium level monitoring and calcium/vitamin D supplementation as necessary to prevent symptomatic hypocalcemia (especially in those with significant bone disease preoperatively) [6-9].

Postoperative Follow-Up and Outcome Measures

Postoperative follow-up was conducted by the endocrinology clinic. Patients were typically seen at approximately 1 month after surgery for an initial evaluation, then at 6 months, 12 months, and annually up to 36 months postoperatively or whenever addressed the clinic. At each follow-up visit, a thorough clinical assessment and laboratory tests were performed. Serum calcium and PTH levels were measured at each visit to monitor residual or recurrent hyperparathyroidism. Additional assessments included serum phosphate. Patients were also queried about the resolution or persistence of hypercalcemia-related symptoms and the occurrence of any new symptoms (such as bone pain, kidney stones, or neuromuscular symptoms) during follow-up.

The primary outcome measure was surgical cure rate, defined as the achievement of normocalcemia after surgery that persisted through the early postoperative period. Operationally, we considered a patient “cured” if they had a normal serum calcium level at the 6-month follow-up visit without intervening hypercalcemia. Persistent pHPT was defined

as failure to normalize calcium levels after surgery, or a return of hypercalcemia (accompanied by elevated PTH) within the first six months postoperatively. Recurrent pHPT was defined as the reappearance of hypercalcemia due to hyperparathyroidism after an initial period of normocalcemia, occurring beyond 6 months post-surgery. All cases of persistence or recurrence were verified by biochemical testing and, when appropriate, confirmatory imaging for localization of any remnant or regrown parathyroid lesion [17,18].

Secondary outcome measures included surgical and postoperative complications and other relevant clinical outcomes. We tracked any occurrences of hypocalcemia and recurrent laryngeal nerve (RLN) injury.

RLN injury: Vocal cord function was assessed by clinical exam (and laryngoscopy if vocal symptoms were present). Transient RLN palsy was defined as voice changes or endoscopic vocal cord paralysis that resolved within 6–12 months, whereas permanent RLN injury was defined by persistent vocal cord paralysis beyond 12 months or requiring intervention (voice therapy or medialization surgery).

All patients who were identified to have persistent or recurrent disease were evaluated for potential re-operation. The timing and success of any remedial parathyroid surgery during the follow-up period were documented, but these re-operations were not counted as new index cases in the cohort (they were considered outcomes of the initial surgery).

Statistical Analysis

All data collected were entered into a secure database and analyzed using statistical software (IBM SPSS Statistics, Version 26.0). Descriptive statistics were used to summarize the patient cohort and surgical outcomes. Continuous variables were reported as mean ± standard deviation (SD) if normally distributed, or as median with interquartile range (IQR) if the distribution was skewed. Categorical variables were summarized as frequencies and percentages. We compared baseline characteristics and outcomes between the two surgical approach groups (unilateral focused parathyroidectomy vs. bilateral neck exploration). For continuous variables, the Student's t-test was used for group comparisons when data were approximately normally distributed; otherwise, the Mann–Whitney U test was employed. Categorical variables (such as cure rates and complication incidences) were compared using the chi-square test or Fisher's exact test, as appropriate. The threshold for statistical significance was set at a two-tailed p value < 0.05.

All statistical analyses adhered to the intention-to-treat principle with respect to the planned surgical approach. The cohort's data analysis followed STROBE guidelines for observational studies, aiming to provide transparent and comprehensive reporting of findings.

RESULTS

During the study period 84 patients were operated on; 12 were excluded from the study population and 72 were included in the analysis. 56 were females (77.78%), 16 were males (22.22%). In the table 1 are the demographics data of the patients included in the study.

Table 1. Demographics of the patients included in the study

Variable	n=72
Age (years)	51.9±14.1
Calcium (mg/dL)	10.9±0.98
Phosphate (mg/dL)	2.8±0.8
Creatinine (mg/dL)	0.7 ±0.3
Alkaline phosphatase (u/L)	112±65
Parathormone (pg/mL)	282.63± 321.48
Bone and muscle pain	58 (80.55%)

Fatigue	**17 (23.61%)**
Kidney stones	**27 (37.50%)**
Gastrointestinal symptoms	**22 (30.55%)**
Osteoporosis	**21 (29.16%)**
Arterial hypertension	**38 (52.77%)**
Depression	**9 (12.5%)**

UFP was employed in 54 patients (75%), whereas BNE in the remaining 18 (25%). Some patients needed another procedure after the recurrence of the disease, 8 of them, while another patient developed parathyroid cancer and needed another surgery. Surgical procedures, findings and pathology are illustrated in table 2.

Table 2. Surgical variables

Variables	**N=72**
First surgery	
UFP	**54 (75%)**
BNE	**18 (25%)**
Second surgery due to recurrence	**8 (11.11%)**
UFP	**4 (5.56%)**
BNE	**4 (5,56%)**
Second surgery due to cancer	**1 (1.38%)**
IOPTH assay performed	**54 (75%)**
Pathology	
Single adenoma	**66 (91.67%)**
Multiple adenoma	**3 (4.16%)**
Hyperplasia	**3 (4.16%)**

Eight patients were reoperated for recurrence of the disease, four from each group.

After UFP 4 patients have persistent HPT, despite initial drop in PTH values, three cases underwent reoperation with BNE, and one of them with right thyroid lobectomy and BNE. Four cases from the 18 of BNE needed second surgery: the missing gland was in the thorax in one case; one had a persistence due to implantation in the forearm, two had the gland inside the thyroid gland and had lobectomy for the removal. One case of hyperplasia evolved after 5 years in a parathyroid cancer with bone metastasis and patient death; first surgery pathology report did not mention malignancy.

No conversion from UFP to BNE was reported at index surgery.

At 6 months postoperatively, cure defined as normocalcemia was high in both groups (UFP 52/54 [96.3%] vs BNE 18/18 [100.0%]). Table 3 summarizes complications and 6-month laboratory values. Bleeding was uncommon (UFP 2/54 [3.7%] vs BNE 1/18 [5.6%]). Transient hypocalcemia occurred in 2/54 (3.7%) after UFP and 2/18 (11.1%) after BNE. Temporary unilateral vocal cord paralysis occurred in 1/54 (1.9%) vs 1/18 (5.6%). Six-month calcium and phosphate values were similar between groups. Reoperation during follow-up occurred in 4/54 (7.4%) after UFP and 4/18 (22.2%) after BNE. Two patients had persistent HPT at six months follow-up, but no clinical symptoms and refused further surgeries.

Table 3. Short-term results and follow-up at six months UFP versus BNE

Variables	**UFP (n=54)**	**BNE (n=18)**	**p**
Bleeding	2	1	1.000
Transient hypocalcemia	2	2	0.259
Temporary unilateral vocal cord paralysis	1	1	0.444
PTH pg/ml	61.80±32.4	60.80±34.6	0.915
Ca at 6 months (mg/dL)	8.9 ±1.15	8.8 ±1.23	0.764
Phosphate at 6 months (mg/dL)	3.30 ±0.4	3.32±0.28	0.816
Reoperation	4	4	0.101
Cure rate at six months	52	18	1.000

DISCUSSIONS

In this single-center retrospective cohort covering 2012–2023, surgery for primary hyperparathyroidism (PHPT) achieved favorable overall outcomes in a predominantly symptomatic population. Of 72 included patients (mean age 51.9 years; 78% female), unilateral focused parathyroidectomy (UFP) was the most frequently employed initial approach (75%), while bilateral neck exploration (BNE) was used in 25%. Pathology demonstrated a predominance of single adenoma (91.7%), with a small proportion of multiple adenomas (4.2%) and hyperplasia (4.2%). Reoperation was required in 11.1% of patients, whereas clinically defined persistent disease without further surgery was observed in 2.8%. One patient developed parathyroid carcinoma with bone metastasis and died, highlighting the clinical impact of rare but aggressive disease.

The clinical profile of our cohort suggests a substantial symptomatic burden at presentation, with bone and muscle pain reported by over 80% of patients, nephrolithiasis in 37.5%, gastrointestinal symptoms in 30.6%, and osteoporosis in 29.2%. This pattern is consistent with "classical" pHPT, where skeletal and renal involvement remain common drivers for surgical referral, and it underscores that pHPT in real-world settings may still present beyond incidentally detected hypercalcemia. Contemporary reviews and guidelines emphasize that parathyroidectomy is the only curative therapy and is appropriate for symptomatic patients and for selected asymptomatic patients meeting guideline criteria [1-5].

A key observation from our series is that a focused approach was feasible in the majority of cases, which is biologically plausible given the predominance of single-gland disease. The proportion of single adenoma in our pathology results parallels large surgical series and supports a strategy of targeted exploration when preoperative localization is concordant and surgical expertise is available [2,6-9]. In the study by Unlu and colleagues, minimally invasive strategies (unilateral neck exploration or focused parathyroid surgery) were used in about two-thirds of patients, with an overall cure rate approaching 98% and low recurrence during follow-up [17]. Similarly, Demir and colleagues reported a single-center experience in which adenoma was the dominant pathology and perioperative outcomes were favorable, reinforcing that contemporary pHPT surgery can be highly effective when supported by systematic preoperative assessment and intraoperative decision-making. [18] Our results align with this overall narrative: most patients can be treated effectively with UFP, while BNE remains essential for selected situations.

Despite the generally favorable outcomes, the need for reoperation in 11.1% of our cohort warrants focused interpretation. In our series, reoperation was most often linked to failure to excise hyperfunctioning tissue at the index operation, ectopic gland location, and complex disease biology such as multiglandular disease or double adenomas [21-25]. Consistent with prior reports, Unlu et al. highlight double adenoma and ectopic localization as important contributors to persistent disease after initial surgery and describe how repeat imaging and tailored reoperative planning can restore high cure rates in experienced centers [17]. This framework helps explain our reoperative cases: four patients required additional surgery after BNE because a missing gland was in the thorax in one case, two in the thyroid gland and because of implantation-related disease in another, illustrating both ectopic pathology and the challenge of surgically distributed parathyroid tissue.

Ectopic and mediastinal disease is particularly relevant when interpreting failures and the need for additional procedures. Persistent hypercalcemia after an apparently adequate cervical exploration should prompt renewed localization efforts with attention to ectopic sites, including the mediastinum. Advanced imaging, particularly 4D-CT, can improve preoperative localization in difficult or reoperative settings and can inform the choice between repeat focused exploration and broader re-exploration [19,20,21,23]. Although some

mediastinal lesions remain approachable from the neck, others may require thoracic access depending on their location and the prior operative field [21-23]. These observations reinforce the need for a structured algorithm for persistent disease that incorporates repeat imaging, multidisciplinary discussion, and individualized operative strategy [22,23].

The low prevalence of multigland disease in our pathology results (8.3% combined multiple adenomas and hyperplasia) likely supported the high effectiveness of focused surgery overall. Nevertheless, multigland disease remains clinically important because it is a consistent driver of persistence and recurrence, and it can be difficult to identify when imaging is discordant or when a dominant adenoma suppresses smaller hyperfunctioning glands [2,3,24,25]. Demir et al. discuss that advanced imaging, including selective use of 4D-CT in difficult cases, can assist localization, particularly in patients with multigland disease or persistent/recurrent pHPT [18-20].

A distinctive operational limitation in our cohort was the inconsistent availability of intraoperative PTH (IOPTH) monitoring during the study period. IOPTH is widely used to biochemically confirm removal of hyperfunctioning tissue during focused operations and to signal the need for further exploration when the expected hormone decline does not occur [12]. In settings where IOPTH is unavailable or results are not rapid, surgeons may rely more heavily on concordant imaging, intraoperative findings, and adjuncts such as frozen section. Unlu et al. describe a setting where PTH measurements were obtained but were not available intraoperatively, limiting their immediate utility for guiding the extent of exploration [17]. Demir et al. discuss the practical barrier of cost and report using frozen section confirmation rather than IOPTH in their cohort [18]. In our series, inconsistent IOPTH availability likely contributed to heterogeneity in intraoperative decision-making across surgeons and years, and it may partially explain the proportion of patients requiring reoperation, especially those with occult additional glands [21-23].

The single case of parathyroid carcinoma emerging after initial hyperplasia is uncommon. Although carcinoma represents a very small fraction of PHPT etiologies, it carries a markedly different prognosis and can manifest with severe skeletal disease and metastasis. This case emphasizes the importance of long-term biochemical follow-up and careful reassessment of patients with atypical courses, recurrent hypercalcemia, or unusually aggressive clinical features, even when the initial histology is not malignant. It also reinforces the value of specialized endocrine follow-up, which in our cohort was provided for up to three years postoperatively.

Strengths of this study include the single-center design, real-world inclusion of both UFP and BNE across a contemporary period, and clinically meaningful follow-up by endocrinologists. Nevertheless, several limitations should be acknowledged. The retrospective design introduces risks of missing data, unmeasured confounding, and selection bias—particularly in how patients were assigned to UFP versus BNE (for example, based on imaging concordance, surgeon preference, or disease severity). The sample size is modest, limiting statistical power for subgroup comparisons. Surgical practice also evolved over the long study interval, and multiple surgeons contributed, which may have increased variability in operative technique, conversion thresholds, and use of adjuncts such as IOPTH.

CONCLUSIONS

Our findings support a selective strategy for pHPT surgery: unilateral focused parathyroidectomy is effective for most patients with concordant localization and an anticipated single adenoma, while BNE remains necessary when localization is negative or discordant, when multigland disease is suspected. The reoperation rate and the occurrence of rare malignant evolution in our cohort underscore the importance of meticulous operative

technique, access to reliable localization and intraoperative confirmation where feasible, and long-term endocrine follow-up to detect persistence, recurrence, and uncommon aggressive disease.

Acknowledgments NA

Funding: We would like to acknowledge VICTOR BABES UNIVERSITY OF MEDICINE AND PHARMACY TIMISOARA for their support in covering the costs of publication for this research paper.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Walker MD, Bilezikian JP. Primary hyperparathyroidism: recent advances. Curr Opin Rheumatol. 2018;30:427–439.
[2] Madkhali T, Alhefdhi A, Chen H, Elfenbein D. Primary hyperparathyroidism. Ulus Cerrahi Derg. 2016;32:58–66.
[3] Bilezikian JP, Silverberg SJ. Clinical practice: asymptomatic primary hyperparathyroidism. N Engl J Med. 2004;350:1746–1751.
[4] Bilezikian JP, Brandi ML, Eastell R, Silverberg SJ, Udelsman R, Marcocci C, et al. Guidelines for the management of asymptomatic primary hyperparathyroidism: summary statement from the Fourth International Workshop. J Clin Endocrinol Metab. 2014;99:3561–3569.
[5] 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;151:959–968.
[6] Udelsman R. Six hundred fifty-six consecutive explorations for primary hyperparathyroidism. Ann Surg. 2002;235:665–670.
[7] Allendorf J, DiGorgi M, Spanknebel K, Inabnet W, Chabot J, LoGerfo P. 1112 consecutive bilateral neck explorations for primary hyperparathyroidism. World J Surg. 2007;31:2075–2080.
[8] Irvin GL 3rd, Carneiro DM, Solorzano CC. Progress in the operative management of sporadic primary hyperparathyroidism over 34 years. Ann Surg. 2004;239:704–708.
[9] Laird AM, Libutti SK. Minimally invasive parathyroidectomy versus bilateral neck exploration for primary hyperparathyroidism. Surg Oncol Clin N Am. 2016;25:103–118.
[10] Chapuis Y, Fulla Y, Bonnichon P, Tarla E, Abboud B, Pitre J, et al. Values of ultrasonography, sestamibi scintigraphy, and intraoperative measurement of 1–84 PTH for unilateral neck exploration of primary hyperparathyroidism. World J Surg. 1996;20:835–839.
[11] Civelek AC, Ozalp E, Donovan P, Udelsman R. Prospective evaluation of delayed technetium-99m sestamibi SPECT scintigraphy for preoperative localization of primary hyperparathyroidism. Surgery. 2002;131:149–157.
[12] Irvin GL 3rd, Solorzano CC, Carneiro DM. Quick intraoperative parathyroid hormone assay: surgical adjunct to allow limited parathyroidectomy, improve success rate, and predict outcome. World J Surg. 2004;28:1287–1292.
[13] Egan RJ, Scott-Coombes DM. The surgical management of sporadic primary hyperparathyroidism. Best Pract Res Clin Endocrinol Metab. 2018;32:847–859.
[14] Singh Ospina NM, Rodriguez-Gutierrez R, Maraka S, Espinosa de Ycaza AE, Jasim S, Castaneda-Guarderas A, et al. Outcomes of parathyroidectomy in patients with primary hyperparathyroidism: a systematic review and meta-analysis. World J Surg. 2016;40:2359–2377.
[15] Westerdahl J, Bergenfelz A. Unilateral versus bilateral neck exploration for primary hyperparathyroidism: five-year follow-up of a randomized controlled trial. Ann Surg. 2007;246:976–980.

[16] Tibblin S, Bondeson AG, Ljungberg O. Unilateral parathyroidectomy in hyperparathyroidism due to single adenoma. Ann Surg. 1982;195:245–252.
[17] Unlu MT, Aygun N, Akgun IE, Yetkin SG, Erol RS, Isgor A, et al. Parathyroidectomy results in primary hyperparathyroidism: analysis of the results from a single center. Med Bull Sisli Etfal Hosp. 2021;55:173–178.
[18] Demir B, Binnetoglu A, Sahin A, Gogas Yavuz D. Single center experience in the surgical management of primary hyperparathyroidism. Clin Exp Otorhinolaryngol. 2020;13:285–290.
[19] Mortenson MM, Evans DB, Lee JE, Hunter GJ, Shellingerhout D, Vu T, et al. Parathyroid exploration in the reoperative neck: improved preoperative localization with 4D-computed tomography. J Am Coll Surg. 2008;206:888–895.
[20] Kelly HR, Hamberg LM, Hunter GJ. 4D-CT for preoperative localization of abnormal parathyroid glands in patients with hyperparathyroidism: accuracy and ability to stratify patients by unilateral versus bilateral disease in surgery-naive and re-exploration patients. AJNR Am J Neuroradiol. 2014;35:176–181.
[21] Shen W, Düren M, Morita E, Higgins C, Duh QY, Siperstein AE, et al. Reoperation for persistent or recurrent primary hyperparathyroidism. Arch Surg. 1996;131:861–867.
[22] Caron NR, Sturgeon C, Clark OH. Persistent and recurrent hyperparathyroidism. Curr Treat Options Oncol. 2004;5:335–345.
[23] Udelsman R. Approach to the patient with persistent or recurrent primary hyperparathyroidism. J Clin Endocrinol Metab. 2011;96:2950–2958.
[24] Alhefdhi A, Schneider DF, Sippel R, Chen H. Recurrent and persistent primary hyperparathyroidism occurs more frequently in patients with double adenomas. J Surg Res. 2014;190:198–202.
[25] Tezelman S, Shen W, Siperstein AE, Duh QY, Clark OH. Persistent or recurrent hyperparathyroidism in patients with double adenomas. Surgery. 1995;118:1115–1122.