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Factors associated with complications of parathyroidectomy in the elderly: A single-center experience

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■ MAIN POINTS

- This study evaluates risk factors for postoperative complications in elderly patients undergoing parathyroidectomy.
- Permanent hypocalcemia was the most frequent complication, significantly associated with multiple adenomas and hyperplasia.
- Elevated preoperative ALP, PTH, and reduced free T3 levels were linked to higher complication rates.
- Histopathological subtype (hyperplasia vs. adenoma) had a significant impact on both complication and mortality rates.
- Comprehensive preoperative evaluation and individualized surgical planning are critical to improving outcomes in geriatric parathyroid surgery.

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■ ABSTRACT

Aim: The expanding older adult population has led to a corresponding increase in parathyroidectomy procedures among geriatric patients. Due to the prevalence of comorbidities and reduced physiological reserves, elderly patients may experience a greater incidence of postoperative complications. This study aims to evaluate the relationship between clinical parameters and complications associated with parathyroidectomy in individuals aged 65 years and above.

Materials and Methods: This is an observational study included patients aged 65 years and older who underwent parathyroid surgery at a tertiary care center between January 2009 and February 2022. Demographic, clinical, surgical, and laboratory data were analyzed. Patients were divided into two groups according to the presence or absence of postoperative complications. A subgroup analysis was conducted for patients who developed permanent hypocalcemia. Statistical comparisons were made between groups. DEXA T scores were obtained from the lumbar spine and hip regions.

Results: Elderly patients accounted for 5.9% (23/388) of all parathyroidectomy cases. The overall postoperative complication rate was 21.7%, and the rate of permanent hypocalcemia was 17.4%. Statistically significant differences were found between the patients with and without complications in terms of free T3, preoperative ALP, PTH, and postoperative calcium levels. Histopathological findings (adenoma vs. hyperplasia) and the number of excised adenomas were significantly associated with complications and permanent hypocalcemia. Mortality was significantly higher in the complication group ($p=0.017$). No cases of persistent hyperparathyroidism were observed during follow-up. A significant association was found between preoperative phosphorus levels and DEXA T-scores.

Conclusion: Parathyroidectomy in elderly patients carries a notable risk of postoperative complications. Identifying high-risk patients based on clinical and biochemical parameters may help guide preoperative planning and postoperative monitoring.

Keywords: Elderly, Parathyroidectomy, Postoperative complications

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■ INTRODUCTION

The increasing elderly population worldwide has led to a significant rise in the number of surgical procedures performed for geriatric patients [1]. Among these, parathyroidectomy remains a crucial intervention, particularly for primary hyperparathyroidism and other parathyroid disorders. While generally considered safe and effective, elderly patients often present with multiple comorbidities, reduced physiological reserve, and age-related metabolic changes, potentially increasing their risk of perioperative and postoperative compli-

cations.

A 2009 guideline published by the World Health Organization (WHO) identified surgical complications as a major cause of global mortality and morbidity, with a significant proportion deemed preventable [2]. Common postoperative complications in elderly patients undergoing parathyroidectomy include permanent hypocalcemia, bleeding, vocal cord paralysis, recurrent laryngeal nerve injury, airway trauma, sepsis, and mortality [3]. Studies indicate that factors such as age, sex, the presence of comorbidities, and preoperative biochemical

markers may influence the risk of these complications [4, 5]. Moreover, the presence of multiple comorbidities in elderly patients has been shown to adversely affect surgical outcomes and prolong recovery times, often leading to higher complication rates [6]. While some reports suggest that age alone should not contraindicate parathyroidectomy, elderly patients remain a vulnerable population requiring careful evaluation and risk stratification [7–9]. Notably, comparative studies have demonstrated that certain complications, such as hypocalcemia and infection, may be more prevalent in elderly individuals compared to younger patients [10, 11].

This study aims to investigate the relationship between clinical parameters and complications occurring during and after parathyroidectomy in patients aged 65 and older. Furthermore, it seeks to identify relevant risk factors to enhance the safety and outcomes of parathyroid surgery in the geriatric population.

MATERIALS AND METHODS

This retrospective observational study was conducted in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines. We reviewed the medical records of patients aged 65 years and older who underwent parathyroid surgery at the Department of General Surgery, Turgut Özal Medical Center, İnönü University, between January 2009 and February 2022. Patients under 65 years old were excluded from this analysis.

The study was approved by the Health Sciences Non-Interventional Clinical Research Ethics Committee of İnönü University Faculty of Medicine (Decision No: 2022-3220) and adhered to the principles of the Declaration of Helsinki.

Study population and data collection

We recorded demographic characteristics, comorbidities, surgical indications, type of anesthesia, surgical procedures (unilateral or bilateral exploration), intraoperative frozen section results, use of neuromonitoring, and histopathological findings. Pre- and postoperative laboratory values, including calcium, phosphorus, PTH, ALP, and other relevant parameters, were also documented. DEXA T-scores were obtained from the lumbar spine and hip regions. Postoperative complications, such as bleeding, seroma, recurrent laryngeal nerve paralysis, transient and permanent hypocalcemia, reoperation, tracheal injury, and postoperative infection/sepsis, were evaluated. Patients were categorized into two groups based on the presence or absence of postoperative complications, and those who developed permanent hypocalcemia were also analyzed separately.

Sample size and sampling method

All eligible patients aged 65 years and older who underwent parathyroid surgery during the study period were included using a non-probability consecutive sampling method. A power

analysis using G*Power Version 3.1.9.7, with 95% confidence and 80% power, indicated a minimum requirement of 4 patients per group to detect an effect size of 2.

Statistical analysis

Numerical data were expressed as medians with minimum and maximum values. The Mann-Whitney U test was used to compare continuous variables between groups, and Fisher's exact test was used for categorical data. Correlations between numerical variables were evaluated using Spearman's rank correlation coefficient. A p-value < 0.05 was considered statistically significant. Statistical analyses were performed using IBM Statistical Software Package for Social Sciences for 22 (SPSS Statistics for Windows, Version 22.0) (IBM, Armonk, NY: IBM Corp.).

RESULTS

A total of 23 patients aged 65 years and older were included in this study, representing 5.9% of the 388 patients aged 18 years and older who underwent parathyroid surgery. Among the older patient group, 3 (13.0%) were male and 20 (87.0%) were female. No perioperative complications were recorded.

Patients were categorized into those who did not develop postoperative complications (n=18, 78.3%) and those who did (n=5, 21.7%). In the complication group, four patients developed permanent hypocalcemia, and one experienced a postoperative hematoma. The median ages of the non-complication and complication groups were 67 (range: 65–79) and 68 (range: 65–75) years, respectively, with no statistically significant difference between the groups (p=0.638). Similarly, there was no significant difference in sex distribution between the groups (p=0.539).

No significant differences were observed between the two groups regarding parathyroid tissue weight, maximum diameter, or the number of excised adenomas. Preoperative and postoperative laboratory parameters, including TSH, free T4, WBC, Hgb, Hct, Plt, lymphocyte count, PLR, RDW, preoperative Ca, P, CRP, vitamin D, postoperative P, PTH, and ALP, did not differ significantly between the complication and non-complication groups.

However, statistically significant differences were found in free T3 (p=0.042), preoperative ALP (p=0.015), preoperative PTH (p=0.046), and postoperative calcium levels (p=0.012) between the two groups.

Complication rates did not differ significantly between groups based on thyroidectomy, use of intraoperative frozen section, or neuromonitorization. Similarly, comorbidities such as diabetes mellitus and hypertension did not significantly impact complication development. However, histopathological findings (adenoma vs. hyperplasia) were significantly associated with complication risk (p=0.048). Survival status also differed significantly, with four patients in the complication group dying during follow-up compared to one

Table 1. Summary of Demographic, Clinical and Laboratory Parameters

	No Postoperative Complication		Postoperative Complication Present		p-value
	n	Median (min.-maks.)	n	Median (min.-maks.)	
Age	18	67 (65-79)	5	68 (65-75)	0.638
Weight (g)	16	1.05 (0.1-2.5)	4	1.65 (0.4-3)	0.335
Largest Diameter (cm)	18	1.9 (0.7-3)	5	2 (0.8-3)	0.914
Number of Adenomas	18	1 (1-2)	5	2 (1-4)	0.055
Hospital Stay (Days)	18	2 (1-6)	5	3 (2-5)	0.111
DEXA T Score	16	-2.55 (-4.5 - -0.2)	2	-2.65 (-3.7 - -1.6)	0.837
Asa Score	17	2 (2-4)	5	3 (2-3)	0.14
TSH	18	1.24 (0.02-6.32)	5	1.76 (0.25-3.84)	0.538
Free T4	18	1.04 (0.55-1.57)	5	1.03 (0.84-1.29)	0.587
Free T3	15	3.18 (1.88-4.91)	5	2.61 (2.48-3.04)	0.042
WBC	18	8.45 (4.53-15.16)	5	8 (6.95-11.2)	0.691
Hgb	18	13.5 (0-17.5)	5	13.4 (9.4-14)	0.363
Hct	18	40.5 (34.1-57.2)	5	38.8 (27.1-43.2)	0.257
Plt	18	240.5 (193-592)	5	246 (169-539)	0.857
Lymphocyte	18	2.28 (1.18-4.44)	5	1.7 (1.2-2.86)	0.199
PLR	18	111.05 (52.14-201.69)	5	184.71 (86.01-283.68)	0.199
RDW	18	14.3 (13-17.6)	5	14.5 (13.2-16.2)	0.914
Preoperative Ca	18	11.25 (10.2-12.5)	5	11 (8.4-11.9)	0.363
Preoperative P	18	2.35 (1.7-3.4)	5	2.7 (1.4-6)	0.587
Preoperative ALP	18	79.5 (56-244)	5	174 (95-925)	0.015
Preoperative CRP	6	0.33 (0.3-0.46)	3	0.84 (0.43-4.5)	0.095
Preoperative PTH	18	198.7 (78.4-506)	5	489 (116-2260)	0.046
Vitamin D	16	28.79 (3.35-48.56)	4	18.02 (8-34.78)	0.682
Peroperative PTH	9	11.8 (4.58-89.4)	4	8.25 (0.2-55.6)	0.414
Postoperative Ca	18	9.1 (8.2-10.2)	5	8.3 (6.5-9.3)	0.012
Postoperative P	15	3.4 (1.5-5)	5	2.5 (1.6-3.7)	0.119
Postoperative PTH	18	41.55 (3.06-121)	5	24.3 (0.7-70.2)	0.29
Postoperative ALP	14	88 (49-231)	5	157 (90-1252)	0.056

		Postoperative Complication n(%)		p-value
		Present	Absent	
Gender	Male	2 (11.1)	1 (20.0)	0.539
	Female	16 (88.9)	4 (80.0)	
Thyroidectomy	Not Performed	6 (33.3)	0 (0)	0.272
	Performed	12 (66.7)	5 (100)	
Intraoperative Frozen	Absent	6 (33.3)	2 (40)	1.000
	Present	12 (66.7)	3 (60)	
Neuromonitoring	Absent	13 (72.2)	4 (80.0)	1.000
	Present	5 (27.8)	1 (20.0)	
Histopathological Result	Adenoma	16 (88.9)	2 (40)	0.048
	Hyperplasia	2 (11.1)	3 (60)	
Diabetes Mellitus	Absent	13 (72.2)	3 (60)	0.621
	Present	5 (27.8)	2 (40)	
Hypertension	Absent	2 (11.1)	0 (0)	1.000
	Present	16 (88.9)	5 (100)	
Survival Status	Alive	15 (83.3)	1 (20)	0.017
	Deceased	3 (16.7)	4 (80)	

Abbreviations: ALP, Alkaline Phosphatase; ASA, American Society of Anesthesiologists; Ca, Calcium; CRP, C-Reactive Protein; DEXA, Dual-Energy X-ray Absorptiometry; Hct, Hematocrit; Hgb, Hemoglobin; P, Phosphorus; PLR, Platelet-to-Lymphocyte Ratio; PTH, Parathyroid Hormone; RDW, Red Cell Distribution Width; TSH, Thyroid-Stimulating Hormone; WBC, White Blood Cell.

patient in the non-complication group (due to postoperative respiratory failure) ($p=0.017$). These outcomes are summarized in Table 1.

Further analysis based on the development of permanent hypocalcemia revealed that four patients (17.4%) developed

this complication, while 19 (82.6%) did not. The median number of excised adenomas was significantly higher in the permanent hypocalcemia group (2.5) compared to the non-hypocalcemia group (1) ($p=0.021$). The median length of hospital stay was also significantly longer in the hypocal-

Table 2. Analysis Results of Factors Affecting Permanent Hypocalcemia Complication

	Permanent Hypocalcemia Absent		Permanent Hypocalcemia Present		p-value
	n	Median (min.-maks.)	n	Median (min.-maks.)	
Age	19	67 (64-79)	4	71 (64-75)	0.667
Weight (g)	17	1.1 (0.1-2.5)	3	1.3 (0.4-3)	0.689
Largest Diameter (cm)	19	2 (0.7-3)	4	1.5 (0.8-3)	0.785
Number of Adenomas	19	1 (1-2)	4	2.5 (1-4)	0.021
Hospital Stay (Days)	19	2 (1-6)	4	3.5 (3-5)	0.027
DEXA T Score	17	-2.5 (-4.5--0.2)	1	-3.7 (-3.7--3.7)	0.444
Asa Score	18	2 (2-4)	4	3 (2-3)	0.262
TSH	19	1.41 (0.02-6.32)	4	1.73 (0.25-3.84)	0.725
Free T4	19	1.04 (0.55-1.57)	4	0.94 (0.84-1.11)	0.218
Free T3	16	3.17 (1.88-4.91)	4	2.72 (2.48-3.04)	0.148
WBC	19	8.4 (4.53-15.16)	4	8.95 (6.95-11.2)	0.557
Hgb	19	13.3 (0-17.5)	4	13.4 (9.4-14)	0.785
Htc	19	40.2 (32.6-57.2)	4	40.65 (27.1-43.2)	0.667
Plt	19	240 (193-592)	4	280 (169-539)	0.557
Lymphocyte	19	2.26 (1.18-4.44)	4	1.8 (1.4-2.86)	0.557
PLR	19	112.11 (52.14-201.69)	4	152.71 (86.01-283.68)	0.409
RDW	19	14.4 (13-17.6)	4	13.95 (13.2-16.2)	0.907
Preoperative Ca	19	11.3 (10.2-12.5)	4	10.35 (8.4-11.9)	0.162
Preoperative P	19	2.3 (1.4-3.4)	4	2.8 (2.5-6)	0.138
Preoperative ALP	19	80 (56-244)	4	234 (119-925)	0.012
Preoperative CRP	6	0.33 (0.3-0.46)	3	0.84 (0.43-4.5)	0.095
Preoperative PTH	19	199.4 (78.4-506)	4	911 (116-2260)	0.116
Vitamin D	17	28.69 (3.35-48.56)	3	26.13 (8-34.78)	1.000
Perioperative PTH	9	11.8 (4.58-89.4)	4	8.25 (0.2-55.6)	0.414
Postoperative Ca	19	9.1 (8.2-10.2)	4	8.1 (6.5-8.3)	0.001
Postoperative P	16	3.35 (1.5-5)	4	2.45 (1.6-3.7)	0.211
Postoperative PTH	19	41.3 (3.06-121)	4	28.85 (0.7-70.2)	0.409
Postoperative ALP	15	90 (49-231)	4	252 (143-1252)	0.020

		Permanent Hypocalcemia n(%)		p-value
		Absent	Present	
Gender	Male	3 (15.8)	0 (0)	1.000
	Female	16 (84.2)	4 (100)	
Thyroidectomy	Not Performed	6 (31.6)	0 (0)	0.539
	Performed	13 (68.4)	4 (100)	
Intraoperative Frozen	Absent	6 (31.6)	2 (50)	0.589
	Present	13 (68.4)	2 (50)	
Neuromonitoring	Absent	14 (73.7)	3 (75)	1.000
	Present	5 (26.3)	1 (25)	
Histopathological Result	Adenoma	17 (89.5)	1 (25)	0.021
	Hyperplasia	2 (10.5)	3 (75)	
Diabetes Mellitus	Absent	14 (73.7)	2 (50)	0.557
	Present	5 (26.3)	2 (50)	
Hypertension	Absent	2 (10.5)	0 (0)	1.000
	Present	17 (89.5)	4 (100)	
Survival Status	Alive	15 (78.9)	1 (25)	0.067
	Deceased	4 (21.1)	3 (75)	

Abbreviations: ALP, Alkaline Phosphatase; ASA, American Society of Anesthesiologists; Ca, Calcium; CRP, C-Reactive Protein; DEXA, Dual-Energy X-ray Absorptiometry; Hct, Hematocrit; Hgb, Hemoglobin; P, Phosphorus; PLR, Platelet-to-Lymphocyte Ratio; PTH, Parathyroid Hormone; RDW, Red Cell Distribution Width; TSH, Thyroid-Stimulating Hormone; WBC, White Blood Cell.

cemia group (3.5 days vs. 2 days, $p=0.027$). Preoperative and postoperative ALP levels and postoperative calcium values were significantly higher in the permanent hypocalcemia group ($p=0.012$, $p=0.020$, and $p=0.001$, respectively). Histopathological diagnosis (hyperplasia vs. adenoma) signif-

icantly affected the development of permanent hypocalcemia ($p=0.021$). These findings are summarized in Table 2.

When comparing patients with preoperative nephrolithiasis ($n=3$) to those without ($n=17$), no statistically significant differences were found in preoperative Ca, P, ALP, CRP, or

Table 3. Comparison of Factors Affecting the Formation of Nephrolithiasis

	No Nephrolithiasis		Nephrolithiasis		p-value
	n	Median (min.-maks.)	n	Median (min.-maks.)	
Preoperative Ca	17	11.2 (8.4-12.5)	3	11 (11-11.9)	0.921
Preoperative P	17	2.3 (1.4-6)	3	2.5 (2.1-3.4)	0.616
Preoperative ALP	17	93 (56-925)	3	80 (65-174)	0.616
Preoperative CRP	5	0.45 (0.31-0.84)	3	0.33 (0.3-0.43)	0.393
Preoperative PTH	17	259 (78.4-2260)	3	184.2 (116-245)	0.258
Perioperative PTH	9	14.6 (5-89.4)	3	4.58 (0.2-6.2)	0.036

Abbreviations: Ca, Calcium; P, Phosphorus; ALP, Alkaline Phosphatase; CRP, C-Reactive Protein; PTH, Parathyroid Hormone.

Table 4. Analysis Results of Parameters Affecting Dexa T Score

	Dexa T Score		
	r _s	p-value	n
Preoperative Ca	0.201	0.424	18
Preoperative P	-0.549	0.018	18
Preoperative ALP	-0.028	0.912	18
Preoperative CRP	-0.357	0.432	7
Preoperative PTH	-0.268	0.282	18
Perioperative PTH	0.329	0.353	10

Abbreviations: Ca, Calcium; P, Phosphorus; ALP, Alkaline Phosphatase; CRP, C-Reactive Protein; PTH, Parathyroid Hormone.

PTH levels. However, perioperative PTH levels were significantly associated with nephrolithiasis ($p=0.036$). These results are summarized in Table 3.

Regarding DEXA T-scores from the lumbar spine and hip, no significant correlations were found with preoperative Ca, ALP, CRP, or PTH values. However, a significant inverse correlation was observed between preoperative phosphorus levels and DEXA T-scores ($p=0.018$). These parameters are presented in Table 4.

■ DISCUSSION

This study investigates the relationship between clinical parameters and postoperative complications following parathyroidectomy in patients aged 65 years and older. As the global elderly population grows, surgical procedures among geriatric patients are becoming increasingly common, necessitating improved perioperative management. In our study, the postoperative complication rate was 21.7%, and permanent hypocalcemia occurred in 17.4% of patients. These rates are higher than those reported in many previous studies [7–9].

In the literature, complication rates vary significantly. Thomas et al. reported approximately 6.5% in elderly patients undergoing parathyroidectomy [7], while Kebebew et al. reported rates as low as 4% [8]. Our higher rate may be attributed to patient comorbidities, lower surgical volume, and inconsistent definitions of minor versus major complications in prior studies [10].

Data in Table 1 showed no significant differences in demographic factors such as age, tissue weight, and maximum

diameter between the groups. However, the free T3 level was significantly lower in the complication group ($p=0.042$). This finding supports previous studies suggesting that low triiodothyronine levels may adversely affect postoperative recovery in elderly patients by impairing metabolic processes [11, 12].

Higher preoperative ALP and PTH levels were also significantly associated with the development of complications ($p=0.015$ and $p=0.046$, respectively). These findings are consistent with those of Nasiri et al., who demonstrated that elevated preoperative biochemical markers such as calcium, PTH, and ALP could predict postoperative calcium decline and hypocalcemia [13]. Therefore, careful biochemical assessment may serve as a useful tool for preoperative risk stratification.

The incidence of permanent hypocalcemia in our study was 17.4%. This subgroup also exhibited longer hospital stays and a higher number of adenomas compared to those without hypocalcemia ($p=0.027$ and $p=0.021$, respectively). Similar findings have been reported by Zamboni et al. and Ghemigian et al., who noted that multiple adenomas and their total weight significantly influence surgical outcomes [14, 15].

Histopathologically, patients with hyperplasia had a significantly higher risk of both general complications and permanent hypocalcemia compared to those with adenomas ($p=0.048$ and $p=0.021$, respectively). Kaya et al. also emphasized that hypocalcemia is more prevalent in patients with parathyroid hyperplasia [16]. These findings underscore the importance of distinguishing between histological subtypes for predicting surgical outcomes.

Minimally invasive parathyroidectomy techniques, including focused parathyroidectomy, intraoperative PTH monitoring, and radioguided approaches, have shown favorable outcomes in elderly patients and can significantly reduce complication rates [17–20]. Although surgical risks are generally higher in older patients, several studies advocate for parathyroidectomy over conservative management even in asymptomatic cases, citing better long-term outcomes [21, 22].

In our study, operative reports showed no recorded intraoperative complications. Some authors suggest that complications which are easily resolved may go unreported due to concerns about the perception of surgical quality [23].

Another factor influencing complication rates is surgical volume and surgeon experience. Studies by Saunders et al. and Stavrakis et al. have demonstrated that procedures performed at high-volume centers or by experienced endocrine surgeons are associated with better outcomes [24, 25]. Our relatively high complication rate may reflect the lower surgical volume, which is typical of single-center experiences.

Regarding survival, the mortality rate was significantly higher in patients who developed complications ($p=0.017$). Four of the five patients in the complication group died during follow-up, while only one patient died in the non-complication group. These findings highlight the importance of rigorous postoperative monitoring and a multidisciplinary approach to care for elderly patients [26]. Optimizing post-surgical care and rehabilitation may also enhance quality of life [27, 28].

Although age alone should not contraindicate surgery, the presence of comorbidities, such as diabetes and hypertension—common in geriatric patients—requires a thorough preoperative evaluation [7, 29]. Multidimensional assessments and risk stratification tools may be particularly helpful in surgical planning.

Limitations

This study has several limitations. First, it was a single-center, retrospective analysis with a limited sample size, which may have affected the generalizability of the results. Second, this study does not include a comparison with younger patients under 65 years of age. Third, 24-hour urinary calcium data were not available for most patients, as such testing was not routinely performed in elderly individuals due to its complexity and lack of direct impact on surgical decision-making. Lastly, randomization, blinding, and sampling methods were not applicable due to the retrospective nature of the study.

CONCLUSION

This study highlights the importance of evaluating complication risks in elderly patients undergoing parathyroidectomy. Complication and mortality rates were found to be higher in this age group, particularly in the presence of multiple adenomas, elevated preoperative biochemical markers, and histopathological diagnosis of hyperplasia. Permanent hypocalcemia was one of the most significant complications, associated with longer hospital stays and poorer outcomes.

The findings emphasize the need for comprehensive preoperative evaluation, including biochemical and radiological assessments, as well as careful surgical planning to minimize risks. Early identification of high-risk patients and the use of minimally invasive techniques may contribute to improved outcomes.

As the global elderly population continues to rise, more older adults are expected to undergo parathyroid surgery. Future multicenter prospective studies with larger sample sizes and comparisons with younger cohorts are warranted to confirm

these findings and enhance the quality and safety of care in this growing patient population.

Ethics Committee Approval: Ethics committee approval for the study was obtained from the Inonu University Faculty of Medicine Health Sciences Non-Interventional Clinical Research Ethics Committee, with the decision numbered 2022-3220.

Informed Consent: This retrospective study was approved by the institutional ethics committee, and the requirement for informed consent was waived.

Peer-review: Externally peer-reviewed.

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