

Risk Factors for Readmission After Parathyroidectomy for Renal Hyperparathyroidism

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Abstract

Background Patients with renal hyperparathyroidism (RHPT) are susceptible to major electrolyte fluctuations following parathyroidectomy, which may predispose them to early readmission. The purpose of this study is to evaluate risk factors for readmission in patients undergoing parathyroidectomy for RHPT.

Methods Patients with renal failure who underwent parathyroidectomy were abstracted from the California Office of Statewide Health Planning and Development (1999–2012). Multivariable logistic regression was used to identify risk factors for readmission within 30 days of discharge.

Results The cohort included 4411 patients, of whom 17% were readmitted. Procedures included subtotal parathyroidectomy (74% of cases) and total parathyroidectomy with autotransplantation (26%). Median time to readmission was 9 days (interquartile range 4–16 days). Electrolyte disturbances including hypocalcemia were present in 36% of readmissions and were the most common cause for readmission. Independent risk factors for readmission included Black race [odds ratio (OR) 1.26, 95% confidence interval (CI) 1.00–1.57], Hispanic race (OR 1.38, 95% CI 1.12–1.71), disposition with home health (OR 1.94, 95% CI 1.35–2.77), disposition to a skilled nursing facility (OR 2.30, 95% CI 1.58–3.35), and total parathyroidectomy with autotransplantation (OR 1.27, 95% CI 1.06–1.52). Advancing age (OR 0.98, 95% CI 0.98–0.99) and surgery at a high-volume hospital (OR 0.53, 95% CI 0.36–0.77) were protective against readmission.

Conclusions Patients undergoing parathyroidectomy for RHPT have a high readmission rate, most frequently for metabolic complications. Increased postoperative vigilance, which may include outpatient laboratory monitoring, may be indicated in patients with risk factors for readmission.

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Introduction

Renal hyperparathyroidism (RHPT) is a common complication of chronic kidney disease with a prevalence of 54% among dialysis patients [1]. RHPT results in significant cardiovascular and skeletal morbidity [2]. Studies have shown decreased mortality in patients with RHPT who underwent parathyroidectomy in comparison with matched controls [3]. Improved medical management with Vitamin D analogs and phosphate binders along with the introduction of calcimimetic drugs (cinacalcet) has decreased the rate of parathyroidectomy for RHPT [4].

Patients with RHPT represent a unique population that is particularly susceptible to postoperative morbidity and mortality [4]. These patients frequently experience major electrolyte fluctuations related to bone hunger and hypocalcemia after parathyroidectomy as well as those intrinsic to end-stage renal disease, which may predispose them to early readmission. However, risk factors associated with readmission after parathyroidectomy are largely unknown [5, 6]. While in theory total parathyroidectomy with autotransplantation may be associated with increased postoperative hypocalcemia due to delayed autograft function in comparison with subtotal parathyroidectomy, population-level studies of RHPT which have shown no differences in readmission among parathyroidectomy techniques may be underpowered [6].

An improved understanding of risk factors for readmission may affect operative decision making, as well as the degree of postoperative vigilance for patients at high risk for readmission. In the current study, we analyzed risk factors associated with readmission after parathyroidectomy for RHPT. We hypothesized that type of surgery (total parathyroidectomy with autotransplantation vs. subtotal parathyroidectomy) would impact the rate of readmission.

Methods

Data source

Patients with renal failure who underwent parathyroidectomy were abstracted from the California Office of Statewide Health Planning and Development (OSHPD) data set from January 1, 1999, through December 31, 2012. The OSHPD database collects information on inpatient, and ambulatory surgery encounters from all licensed hospitals and ambulatory surgery clinics in California. This study was approved by the University of California Los Angeles Institutional Review Board. A waiver of informed consent was obtained from the institutional review board due to the use of publicly available deidentified data.

Study population

Inclusion criteria were adapted from Anderson et al. and Kuo et al. to identify patients who underwent parathyroidectomy [Current Procedural Terminology (CPT) 60500, 60502, 60505; International Classification of Diseases, Ninth Revision (ICD9) 06.8, 06.81, 06.89]. Patients who underwent hemodialysis or peritoneal dialysis within 2 weeks prior to surgery were identified (CPT 90935–90999, ICD9 39.95, 54.98). Additionally, patients with a diagnosis code of secondary hyperparathyroidism

(ICD9 588.851) or renal failure requiring dialysis (ICD9 403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 585.5, 585.6, 586, V42.0, V45.11, V45.12, V56.X, 39.965, 54.98) at the time of their parathyroidectomy were included [5, 6].

Data extracted from the OSHPD database included age, race, disposition, insurance status, hospital volume, and length of stay. Patients who underwent parathyroidectomy with autotransplantation were identified with CPT procedure code 60512 and ICD 9 code 06.95. Patients who were readmitted within 30 days of discharge were identified. The most frequent principal diagnosis codes for readmissions (accounting for 80% of all principal diagnosis) were identified. Codes were then individually categorized as being related to electrolyte/metabolic disturbances, renal, cardiac, gastrointestinal, respiratory, neurological, or other (Supplemental Table 1). The Charlson Comorbidity Index (CCI) was used to adjust outcomes based on pre-existing medical comorbidities. Hospital volume was defined by the annual volume of parathyroid surgery and categorized into quintiles.

Statistical analysis

Summary statistics were used to describe baseline characteristics. Standardized differences were used to represent differences in effect sizes between groups. Standardized differences of 0.2, 0.5, and 0.7 represent small, medium, and large effect sizes, respectively [7]. Multivariable logistic regression with backwards elimination of covariates with $P < .20$ was used to identify risk factors for readmission within 30 days of discharge. All tests were 2 sided and $P < .05$ was considered statistically significant. Statistical analysis was performed with SAS version 9.4 (SAS Institute, Inc).

Results

We identified 4411 patients who underwent parathyroidectomy for RHPT in California from 1999 through 2012. The median age was 51 years [interquartile range (IQR) 40–60 years] and 2437 (55%) patients were female. The initial surgical procedure was subtotal parathyroidectomy in 3263 (74%) patients and total parathyroidectomy with autotransplantation in 1148 (26%) patients. A total of 740 (17%) patients were readmitted within 30 days of discharge, and the median time to readmission was 9 days (IQR 4–16 days).

Electrolyte disturbances including hypocalcemia were present in 36% ($n = 269$) of readmissions and were the most common diagnosis associated with readmission. Additional diagnoses associated with readmission included those related to end-stage renal disease (ESRD) (15%),

Table 1 Demographic characteristics of patients readmitted versus not readmitted <30 days after parathyroidectomy for renal hyperparathyroidism

	Total cohort (n = 4411)	No readmission (n = 3671)	Readmission (n = 740)	Standardized difference ^a
<i>Age (years)</i>				0.215
Median (IQR)	51 (40–60)	51 (41–61)	47 (37–57)	
<18	33 (0.8%)	29 (0.8%)	4 (0.5%)	
18–45	1582 (35.9%)	1251 (34.1%)	331 (44.7%)	
45–65	2106 (47.7%)	1796 (48.9%)	310 (41.9%)	
>65	690 (15.6%)	595 (16.2%)	95 (12.8%)	
<i>Sex</i>				0.033
Male	1973 (44.7%)	1645 (44.5%)	338 (45.7%)	
Female	2437 (55.3%)	2035 (55.4%)	402 (54.3%)	
<i>Race/ethnicity</i>				0.204
White	1555 (35.3%)	1346 (36.7%)	209 (28.2%)	
Black	1019 (23.1%)	829 (22.6%)	190 (25.7%)	
Hispanic	1239 (28.1%)	992 (27.0%)	247 (33.4%)	
Asian/Pacific Islander	513 (11.6%)	430 (11.7%)	83 (11.2%)	
Other	85 (1.9%)	74 (2.0%)	11 (1.5%)	
<i>Insurance</i>				0.174
Private	657 (14.9%)	568 (15.5%)	89 (12.0%)	
Medicare	3194 (72.4%)	2657 (72.4%)	537 (72.6%)	
Medi-Cal	410 (9.4%)	315 (8.6%)	95 (12.8%)	
Self pay	15 (0.3%)	12 (0.3%)	3 (0.4%)	
Other	135 (3.2%)	119 (3.2%)	16 (2.2%)	

^aStandardized differences of 0.2, 0.5, 0.8 represent small, medium, and large effect sizes, respectively [7]

cardiac (8.9%), gastrointestinal (6.9%), respiratory (6.1%), or neurologic (3.5%) disease, or procedure-related complications (5.1%) such as surgical site infection, hematoma, or seroma.

Patients readmitted within 30 days of parathyroidectomy had a lower median age in comparison with patients not readmitted [47 years, IQR 37–57 years vs. 51 years, IQR 41–61 years; standardized difference (SD) = 0.22] (Table 1). Readmitted patients were also less frequently White (28.2% vs. 36.7%) and more frequently Black (25.7% vs. 22.6%) or Hispanic race (33.4% vs. 27.0%, SD = 0.20). They also less frequently had private insurance (12.0% vs. 15.5%) and more frequently had Medi-Cal (12.8% vs. 8.6%).

Readmitted patients were more frequently discharged to home with home health services (6.8% vs. 3.4%) or to skilled nursing facilities (7.3% vs 3.2%, SD = 0.27) when compared to patients who were not readmitted (Table 2). No differences in readmission rates were observed with respect to distance from the treating facility. Operative factors associated with differences in readmission rates included the surgical procedure performed, initial length of stay, and hospital volume. Readmitted patients more frequently underwent total parathyroidectomy with autotransplantation in comparison with patients who were not

readmitted within 30 days (31.8% vs 24.9%, SD = 0.15). Patients with a readmission also more frequently underwent surgery in a hospital in the lowest volume quintile when compared to non-readmitted patients (22.6% vs. 18.0%, SD = 0.18). The median initial length of stay was longer in readmitted patients in comparison with non-readmitted patients (5 days, IQR 3–9 days vs. 3 days, IQR 2–7 days, SD = 0.16). However, there was no difference in median length of stay between patients who underwent total parathyroidectomy with autotransplantation versus subtotal parathyroidectomy [4 (IQR 2–7) days versus 3 (IQR 2–7)].

On multivariable analysis, independent risk factors for readmission included Black [odds ratio (OR) 1.26, 95% confidence interval (CI) 1.00–1.57] or Hispanic (OR 1.38, 95% CI 1.12–1.71) race, disposition with home health (OR 1.94, 95% CI 1.5–2.77) or to a skilled nursing facility (SNF) (OR 2.30, 95% CI 1.58–3.35), increased initial length of stay (OR 1.01, 95% CI 1.00–1.02), and total parathyroidectomy with autotransplantation (OR 1.27, 95% CI 1.06–1.52). Advancing age (OR 0.98 per year, 95% CI 0.98–0.99) and surgery at a high-volume hospital (OR 0.53, 95% CI 0.36–0.77) were protective against readmission (Figs. 1, 2).

Table 2 Clinical characteristics of patients readmitted versus not readmitted <30 days after parathyroidectomy for renal hyperparathyroidism

	Total cohort (n = 4411)	No readmission (n = 3671)	Readmission (n = 740)	Standardized difference ^a
<i>Initial length of stay (days)</i>	4 (2–7)	3 (2–7)	5 (3–9)	0.164
Median (IQR)				
<i>Distance to treating facility (mi.)</i>	6.8 (3.6–13.4)	6.9 (3.6–13.7)	6 (3.6–11.6)	0.068
Median (IQR)				
<i>CCI</i>				0.253
0	782 (17.7%)	695 (18.9%)	87 (11.8%)	
1	331 (7.5%)	282 (7.7%)	49 (6.6%)	
2	1901 (43.1%)	1590 (43.3%)	311 (42.0%)	
3	649 (14.7%)	521 (14.2%)	128 (17.3%)	
4+	748 (17.0%)	583 (15.9%)	165 (22.3%)	
<i>Hospital volume</i>				0.184
Lowest	820 (18.8%)	654 (18.0%)	166 (22.6%)	
Lower-middle	1462 (33.4%)	1241 (34.0%)	221 (30.1%)	
Middle	1126 (25.7%)	925 (25.4%)	201 (27.4%)	
Higher-middle	590 (13.5%)	486 (13.4%)	104 (14.2%)	
Highest	376 (8.6%)	334 (9.2%)	42 (5.7%)	
<i>Disposition</i>				0.271
Home	3894 (88.28%)	3273 (89.16%)	621 (83.92%)	
Home health	176 (3.99%)	126 (3.43%)	50 (6.76%)	
Skilled nursing	172 (3.90%)	118 (3.21%)	54 (7.30%)	
Acute care	17 (0.39%)	16 (0.44%)	1 (0.14%)	
Other	152 (3.45%)	138 (3.76%)	14(1.89%)	
<i>Surgery</i>				0.153
sPTX	3263 (74.0%)	2758 (75.1%)	505 (68.2%)	
tPTX-AT	1148 (26.0%)	913 (24.9%)	235 (31.8%)	

CCI Charlson Comorbidity Index, sPTX subtotal parathyroidectomy, tPTX-AT total parathyroidectomy with autotransplantation
^aStandardized differences of 0.2, 0.5, 0.8 represent small, medium, and large effect sizes, respectively [7]

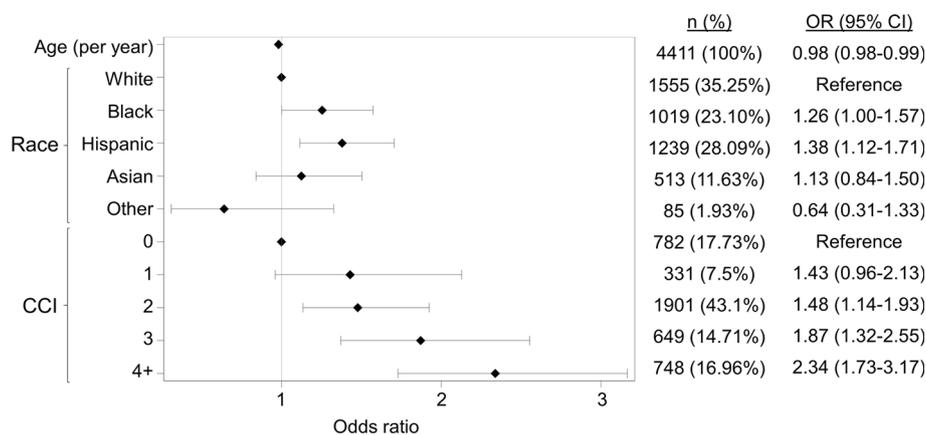


Fig. 1 Patient risk factors associated with readmission <30 days after parathyroidectomy for renal hyperparathyroidism (figure reflects the results of a single multivariable regression model). OR odds ratio, CI confidence interval, CCI Charlson Comorbidity Index

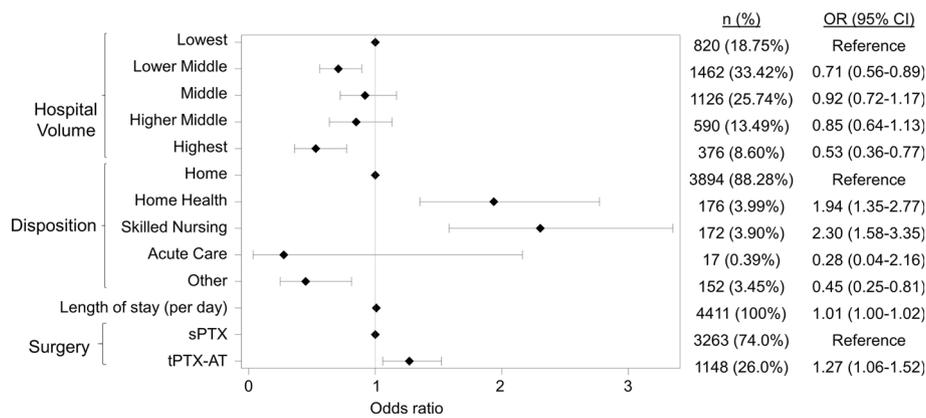


Fig. 2 Clinical risk factors associated with readmission <30 days after parathyroidectomy for renal hyperparathyroidism (figure reflects the results of a single multivariable regression model). *OR* odds ratio, *CI* confidence interval, *sPTX* subtotal parathyroidectomy, *tPTX-AT* total parathyroidectomy with autotransplantation

Discussion

In this population-based study of patients with RHPT, the readmission rate for parathyroidectomy (17%) was higher compared to that of patients with primary hyperparathyroidism (3.8% as reported in the literature) [8]. The most common reason for readmission was electrolyte disturbances. Independent risk factors for readmission included total parathyroidectomy with autotransplantation, disposition with home health or to a SNF, and non-White race, while advanced age, private insurance, and surgery at a high-volume hospital were protective against readmission.

Readmission after parathyroidectomy for RHPT is a common occurrence and is nearly fivefold greater than the rate of readmission for primary HPT [8]. This likely reflects the differences in disease mechanism and the increased disease burden in RHPT patients due to disturbances in mineral metabolism and abnormal hormone secretion. Reports of readmission rates after parathyroidectomy for RHPT have ranged from 4 to 17% in previous studies using national administrative datasets [5, 6]. The 17% 30-day readmission rate in our study is consistent with prior reports.

Electrolyte disturbances were present in 36% of readmissions and were the most common diagnosis associated with readmission. The sharp reduction in PTH after surgery can cause multifactorial hypocalcemia and accelerated bone remineralization (“hungry bone syndrome”). Hypocalcemia is an important post-surgical complication in primary hyperparathyroidism, but it is compounded in RHPT by decreased renal calcitriol production and hyperphosphatemia [9]. The rate of severe hypocalcemia after parathyroidectomy is approximately 20% and is usually managed with prolonged high-dose supplementation of calcium and calcitriol [10, 11].

The choice of surgical procedure for RHPT (subtotal parathyroidectomy or total parathyroidectomy with autotransplantation) is largely based on surgeon preference due to the lack of clear evidence supporting one technique over the other [5, 6]. While in theory total parathyroidectomy with autotransplantation would be associated with increased readmission rates due to delayed autograft function, previous studies have reported no differences in readmission after subtotal parathyroidectomy versus total parathyroidectomy with autotransplantation [5, 6]. However, median operative time and postoperative length of stay were both longer in patients who received total parathyroidectomy with autotransplantation. In contrast to prior studies, our study found total parathyroidectomy with autotransplantation to be a significant risk factor for readmission within 30 days, most often due to electrolyte disturbances including hypocalcemia. Our findings may be due to a fourfold increase in sample size in comparison with prior studies.

In addition to physiological reasons for readmission, socioeconomic factors such as racial disparities and disposition play an important role. Our study found disparities in readmission rates after parathyroidectomy for RHPT in Black and Hispanic patients when compared to those of white patients. Similar disparities in readmission rates have previously been reported in Black patients undergoing cardiac, vascular, orthopedic, and general surgical procedures [12]. Disposition to a SNF or with home health was also significant risk factors associated with readmission in our study. Overall rates of readmission from SNFs are decreasing but remain high: 23.5% of Medicare beneficiaries discharged from the hospital to a SNF were readmitted within 30 days [13]. These findings may indicate an increased disease burden of patients who receive subacute

care in a SNF or a lack of resources to care for the complexities of post-parathyroidectomy patients with RHPT.

Advancing age appeared to have some protective effect against readmission in our study. This may be due to chronic illness and disease burden in the population of patients with RHPT that dominated as the most important predictors of readmission. Further studies are necessary to determine whether younger patients with RHPT have a higher rate of severe postoperative bone hunger and hypocalcemia. Surgery at high-volume hospitals were protective against readmission. This may be due to differences in surgical technique or postoperative laboratory monitoring and medication dosing to prevent hypocalcemia. Interestingly, increased initial length of stay was also identified as a minor predictor of readmission. There was therefore no evidence that early discharge during the initial hospitalization precipitated readmission.

Our study has several limitations inherent to registry data. OSHPD is an administrative database and is subject to missing data and coding errors. In addition, it is a statewide dataset rather than a national dataset like NISQP. However, OSHPD provides more details regarding the reasons for readmission in addition to socioeconomic factors that are not available through NSQIP. Despite these limitations, our readmission rate is consistent with prior population-based studies. OSHPD also lacks clinical data including laboratory results, which would allow for a more precise evaluation of hypocalcemia and bone hunger after parathyroidectomy.

In conclusion, patients have a higher readmission rate following parathyroidectomy for RHPT when compared to parathyroidectomy following primary HPT. This is frequently due to electrolyte disturbances and independent risk factors including total parathyroidectomy with autotransplantation, disposition to a skilled nursing home, and minority race. Increased postoperative vigilance, which may include outpatient laboratory monitoring, may be indicated in a subset of patients who are at high risk for readmission. Additionally, our findings that socioeconomic factors affect readmission rates corroborate previous work. Further research should be conducted on the effects of socioeconomic factors on readmission rates and strategies to mitigate these health disparities.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

- Hedgeman E et al (2015) International Burden of chronic kidney disease and secondary hyperparathyroidism: a systematic review of the literature and available data. *Int J Nephrol* 2015:1–15
- Cannata-Andía JB, Carrera F (2008) The pathophysiology of secondary hyperparathyroidism and the consequences of uncontrolled mineral metabolism in chronic kidney disease: the role of COSMOS. *NDT Plus* 1:i2–i6
- Sharma J et al (2012) Improved long-term survival of dialysis patients after near-total parathyroidectomy. *J Am Coll Surg* 214:400–407 (**discussion 407–408**)
- Ishani A et al (2015) Clinical outcomes after parathyroidectomy in a nationwide cohort of patients on hemodialysis. *Clin J Am Soc Nephrol CJASN* 10:90–97
- Kuo LE, Wachtel H, Karakousis G, Fraker D, Kelz R (2014) Parathyroidectomy in dialysis patients. *J Surg Res* 190:554–558
- Anderson K et al (2017) Subtotal vs. total parathyroidectomy with autotransplantation for patients with renal hyperparathyroidism have similar outcomes. *Am J Surg*. <https://doi.org/10.1016/j.amjsurg.2017.07.018>
- Thomas LE, Pencina MJ (2016) Do not over (P) value your research article. *JAMA Cardiol* 1:1055
- Mullen MG et al (2014) Risk factors for 30-day hospital readmission after thyroidectomy and parathyroidectomy in the United States: an analysis of National Surgical Quality Improvement Program outcomes. *Surgery* 156:1423–1430 (**discussion 1430–1431**)
- Cunningham J, Locatelli F, Rodriguez M (2011) Secondary hyperparathyroidism: pathogenesis, disease progression, and therapeutic options. *Clin J Am Soc Nephrol CJASN* 6:913–921
- Jofre R et al (2003) Parathyroidectomy: whom and when? *Kidney Int* 63(Suppl 85):S97–S100. <https://doi.org/10.1046/j.1523-1755.63.s85.23.x>
- Brasier AR, Nussbaum SR (1988) Hungry bone syndrome: clinical and biochemical predictors of its occurrence after parathyroid surgery. *Am J Med* 84:654–660
- Tsai TC, Joynt KE, Orav EJ, Gawande AA, Jha AK (2013) Variation in surgical-readmission rates and quality of hospital care. *N Engl J Med* 369:1134–1142
- Mor V, Intrator O, Feng Z, Grabowski DC (2010) The revolving door of rehospitalization from skilled nursing facilities. *Health Aff* 29:57–64