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Safety and Efficacy of Near-Total Parathyroidectomy for Refractory Secondary Hyperparathyroidism in a Chinese Cohort: A Single-Center Retrospective Study

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Research Article

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Abstract

Background

Secondary hyperparathyroidism (SHPT) is a prevalent complication of mid-to-late stage chronic kidney disease (CKD). For patients with refractory SHPT unresponsive to medical therapy, parathyroidectomy (PTX) remains the definitive treatment, yet traditional techniques (subtotal [sPTX], total [tPTX], or total with autotransplantation [tPTX + AT]) carry inherent risks of recurrence or permanent hypoparathyroidism. Near-total parathyroidectomy (n-tPTX), a specialized variant preserving a minimal vascularized parathyroid remnant (~ 80–100 mg) to balance efficacy and safety, has demonstrated promise internationally but lacks robust data in Chinese populations.

Methods

A single-center retrospective cohort study analyzed 156 consecutive patients with refractory SHPT who underwent n-tPTX at China-Japan Friendship Hospital (Beijing, China) from July 1, 2017, to December 31, 2018. The procedure involved resecting most hyperplastic glands while retaining one minimal hyperplastic gland (~ 80–100 mg) to mitigate permanent hypoparathyroidism. Postoperative monitoring included dynamic assessment of biochemical parameters (iPTH, calcium, phosphorus), symptom relief, complications, and recurrence. Multivariable logistic regression identified risk factors for hypocalcemia (age, dialysis duration, preoperative iPTH), and Cox proportional hazards modeling explored recurrence predictors.

Results

All 156 n-tPTX procedures were successfully completed under general anesthesia, with a mean operative time of 53 minutes and no intraoperative mortality or conversion to open surgery. At 6 months postoperatively, symptom relief was significant: bone pain resolved completely in 92% of patients, pruritus improved in 89%, and insomnia resolved in 85%; skeletal deformities (present in 42.3% of patients) stabilized without progression. Biochemical normalization was achieved: iPTH decreased from a mean of 2032 pg/ml (range: 663–3741) to 28 pg/ml (range: 5–234), serum calcium from 2.52 mmol/L (2.03–2.86) to 2.01 mmol/L (1.47–2.75), and serum phosphorus from 2.22 mmol/L (0.86–3.37) to 1.88 mmol/L (0.53–2.84) (all $P < 0.01$). Recurrent laryngeal nerve injury was absent (0%). At 36-month follow-up, no hyperparathyroidism recurrence was observed.

Conclusions

n-tPTX is a safe and effective surgical strategy for refractory SHPT in Chinese patients, characterized by high symptom relief rates, biochemical control, low recurrence (0% at 36 months), and manageable

hypocalcemia. Its advantages—balancing reduced recurrence (vs. sPTX) and avoided severe hypocalcemia (vs. tPTX)—position it as a preferred alternative to traditional PTX modalities.

Background

Chronic kidney disease (CKD) is a major global public health concern, with a reported prevalence affecting over 10% of the adult population worldwide[1]. In China, the disease burden is particularly severe, with an estimated 130 million to over 160 million affected individuals[2]. Secondary hyperparathyroidism (SHPT) is a frequent and serious complication of CKD, especially among patients undergoing long-term hemodialysis[3]. Studies indicate a high incidence of SHPT in this population, with a significant proportion of patients developing refractory disease[4].

SHPT is characterized by excessive parathyroid hormone (PTH) secretion and dysregulated mineral metabolism, leading to persistent hyperphosphatemia and disturbances in calcium homeostasis[5]. These biochemical abnormalities contribute to multi-system damage, including debilitating bone pain, pruritus, skeletal deformities, and accelerated cardiovascular calcification, which collectively severely impair patients' quality of life and are associated with increased cardiovascular morbidity and mortality[6].

The initial management of SHPT relies on medical therapy, including phosphate binders, active vitamin D analogs, and calcimimetics[7]. While these measures can slow disease progression, a substantial proportion of patients progress to refractory or refractory SHPT that is unresponsive to pharmacological intervention[8]. For these patients, parathyroidectomy (PTX) remains the definitive and most effective treatment option to alleviate symptoms and improve outcomes[9].

Several surgical strategies exist for PTX, primarily subtotal parathyroidectomy (sPTX), total parathyroidectomy (tPTX), and total parathyroidectomy with autotransplantation (tPTX + AT)[10]. Each technique presents a distinct risk-benefit profile concerning recurrence rates, postoperative hypocalcemia, and the potential for permanent hypoparathyroidism[11]. Currently, there is no conclusive high-level evidence from randomized controlled trials to establish the superiority of one technique over another, and the choice often depends on individual patient factors and surgeon experience[12].

Near-total parathyroidectomy (n-tPTX) is a specialized variant of sPTX that involves preserving a minimal amount of vascularized parathyroid tissue in situ. This approach aims to balance the competing risks: minimizing the recurrence rate associated with sPTX while avoiding the permanent hypoparathyroidism and severe, prolonged hypocalcemia that can follow tPTX. First described by Milas et al., n-tPTX has been shown to be effective[11]. However, large-scale, long-term outcome data, particularly from Chinese populations, remain limited.

Since 2017, our institution has adopted n-tPTX as a primary surgical strategy for patients with refractory SHPT. This study presents a retrospective analysis of the clinical outcomes of 156 consecutive patients who underwent n-tPTX at our center, with a focus on surgical efficacy, safety profile, and recurrence rates.

Methods

Study Design

This retrospective cohort study analyzed 156 consecutive patients with refractory secondary hyperparathyroidism (SHPT) who underwent near-total parathyroidectomy (n-tPTX) at China-Japan Friendship Hospital (Beijing, China) from July 1, 2017, to December 31, 2018. The study was approved by the Ethics Committee of China-Japan Friendship Hospital and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

Inclusion and Exclusion Criteria

Inclusion criteria: (1) Refractory SHPT, defined as persistent hyperparathyroidism unresponsive to maximal medical therapy (including phosphate binders, active vitamin D analogs, and calcimimetics) with intact parathyroid hormone (iPTH) > 800 pg/ml[12]; (2) eligibility for parathyroidectomy (PTX) confirmed by a multidisciplinary team (MDT) consensus[13]; (3) no absolute surgical contraindications (e.g., uncontrolled coagulopathy); (4) intraoperative identification of ≥ 4 hyperplastic parathyroid glands[10]; (5) ability to preserve a vascularized parathyroid tissue remnant (~80–100 mg, "morphologically normal" appearance) in situ[11]. **Exclusion criteria**: (1) Identification of ≤ 3 parathyroid glands intraoperatively[10]; (2) incomplete follow-up data (< 3 months).

Surgical Indications

Indications for n-tPTX were based on the 2023 KDIGO Clinical Practice Guideline for CKD-MBD[13]: (1) end-stage renal disease (ESRD) with refractory SHPT (iPTH > 800 pg/ml) and severe hypercalcemia (> 2.75 mmol/L) or hyperphosphatemia (> 1.78 mmol/L); (2) medication-refractory symptoms (bone pain, pruritus, insomnia) significantly impairing quality of life[14]; (3) imaging (ultrasound or CT) confirming at least one enlarged parathyroid gland (> 1 cm in diameter)[15].

Patient Characteristics

A total of 156 patients (83 females, 73 males) were enrolled, with a mean age of 47.3 years (range: 19–74) and mean dialysis duration of 8 years (range: 0.6–22). All patients presented with bone pain (100%, 156/156), 88.5% (138/156) with pruritus, 87.2% (136/156) with insomnia, 42.3% (66/156) with skeletal deformities/height loss, and 2.6% (4/156) with a history of pathological fracture. Baseline characteristics are summarized in Table 1.

Table 1
Baseline Characteristics of 156 Patients

General Information	SHPT Patient Data
Female (n)	83
Male (n)	73
Bone pain/post-activity arthralgia (n, %)	156 (100%)
Pruritus (n, %)	138 (88.5%)
Insomnia (n, %)	136 (87.2%)
Skeletal deformities/height loss (n, %)	66 (42.3%)
History of pathological fracture (n, %)	4 (2.6%)
Age (years, mean ± SD)	47.3 ± 12.5
Dialysis duration (years, mean ± SD)	8.0 ± 5.2

Preoperative, Surgical, and Postoperative Management

Preoperatively, meticulous preparation was undertaken to optimize patient status and minimize perioperative risks. Patients scheduled for near-total parathyroidectomy (n-tPTX) underwent daily hemodialysis for 2 days prior to surgery to stabilize electrolyte balance, with a particular focus on mitigating hyperkalemia—a common complication in end-stage renal disease that increases anesthetic and surgical risks. The day before surgery, a heparin-free dialysis session was performed to reduce systemic anticoagulation, thereby minimizing bleeding risk during the procedure[3]. This protocol aligns with established practices for managing metabolic derangements in dialysis-dependent patients undergoing major surgery.

Surgically, the procedure was performed under general anesthesia with endotracheal intubation. A standard cervical arc incision (approximately 5–7 cm in length, aligned with natural skin creases) was made to optimize cosmetic outcomes. Subcutaneous tissue was dissected to create mobile flaps, and the median cervical fascia was incised to expose the strap muscles, which were retracted laterally to access the prethyroidal space. The thyroid gland was gently elevated and retracted medially to facilitate bilateral neck exploration, during which ≥ 4 hyperplastic parathyroid glands were systematically identified. Larger glands exhibiting marked hyperplasia were excised, while a single hyperplastic gland (approximately 80–100 mg, with a vascular pedicle and morphologically normal appearance) was preserved in situ to reduce the risk of permanent hypoparathyroidism[16]. Throughout the dissection, the recurrent laryngeal nerve was meticulously identified and protected using microsurgical techniques, with care taken to avoid thermal or mechanical injury.

Postoperatively, care focused on managing metabolic sequelae and ensuring recovery. Heparin-free dialysis was initiated on postoperative day 2, with subsequent sessions adjusted by the nephrology team based on serial electrolyte monitoring. Proactive management of hyperkalemia involved insulin-dextrose infusions (10 units of regular insulin with 25 g dextrose intravenously) for acute elevations, followed by dietary potassium restriction. Hypocalcemia, occurring in 53.2% of patients, was addressed with an initial intravenous calcium gluconate bolus (1–2 g) followed by a continuous infusion (1–2 mg/kg/h), transitioning to oral calcium carbonate (1–2 g three times daily) and active vitamin D analogs (calcitriol 0.25–0.5 μg twice daily) once stable[6]. Serum calcium, phosphorus, and iPTH levels were monitored every 6–12 hours for the first 48 hours, then daily until discharge. One patient developed transient heart failure due to delayed dialysis, which resolved with intensive care unit–directed diuresis and inotropic support. All other complications, including mild hypocalcemic symptoms (paresthesias), were managed conservatively without sequelae.

Statistical Analysis

Data were analyzed using SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed via the Shapiro-Wilk test. Normally distributed data are presented as mean ± standard deviation (SD), with intergroup comparisons using independent samples *t*-tests. Categorical variables are expressed as frequencies (percentages), with comparisons via χ^2 tests. A two-tailed $P < 0.05$ was considered statistically significant. Multivariable logistic regression was performed to identify predictors of postoperative hypocalcemia (e.g., age, dialysis duration, preoperative iPTH), though results are not shown here due to space constraints[8].

Results

Surgical Outcomes

All 156 near-total parathyroidectomy (n-tPTX) procedures were successfully completed under general anesthesia, with a mean operative time of 53 minutes (range: 33–90 minutes). No conversions to open surgery or intraoperative mortality occurred, reflecting the technical feasibility of this approach in a cohort of patients with refractory secondary hyperparathyroidism (SHPT).

Clinical Symptom Relief

Preoperatively, all 156 patients presented with bone pain or post-activity arthralgia, 138 (88.5%) reported pruritus, and 136 (87.2%) experienced insomnia. Postoperatively, all symptoms demonstrated significant improvement: bone pain resolved completely in 92% (144/156) of patients by 6 months, pruritus improved in 89% (123/138), and insomnia resolved in 85% (116/136). Skeletal deformities (present in 66 patients, 42.3%) stabilized without progression during follow-up.

Biochemical Changes

Compared with preoperative values, n-tPTX significantly reduced serum biochemical parameters indicative of SHPT activity (Table 2). Serum intact parathyroid hormone (iPTH) decreased from a mean of 2032 pg/ml (range: 663–3741) to 28 pg/ml (range: 5–234), serum calcium declined from 2.52 mmol/L (2.03–2.86) to 2.01 mmol/L (1.47–2.75), and serum phosphorus fell from 2.22 mmol/L (0.86–3.37) to 1.88 mmol/L (0.53–2.84), with all changes reaching statistical significance ($P < 0.01$). In contrast, serum alkaline phosphatase (ALP) levels remained unchanged (preoperative: 530 U/L [61–2242]; postoperative: 453 U/L [31–2297]; $P = 0.13$), suggesting minimal impact on bone turnover markers. Biochemical Parameters after n-tPTX are summarized in Table 2.

Table 2
Biochemical Parameters After n-tPTX

Biochemical Parameter	**Preoperative (Range, Mean)**	**Postoperative (Range, Mean)**	***P* Value**
Intact PTH (iPTH, pg/ml)	663–3741 (2032)	5–234 (28)	< 0.01
Serum Calcium (mmol/L)	2.03–2.86 (2.52)	1.47–2.75 (2.01)	< 0.01
Serum Phosphorus (mmol/L)	0.86–3.37 (2.22)	0.53–2.84 (1.88)	< 0.01
Alkaline Phosphatase (ALP, U/L)	61–2242 (530)	31–2297 (453)	0.13

Postoperative Complications and Recurrence

No recurrent laryngeal nerve injuries occurred. Postoperative hypocalcemia developed in 53.2% (83/156) of patients but was effectively managed with intravenous calcium gluconate (initial bolus followed by continuous infusion), oral calcium carbonate, or high-calcium dialysate, maintaining normocalcemia without severe complications or mortality. One patient (0.6%) developed transient heart failure due to delayed dialysis, which resolved after intensive care unit (ICU) admission and diuretic/inotropic support. At 36-month follow-up, no cases of hyperparathyroidism recurrence were observed, underscoring the durability of n-tPTX in this cohort.

Discussion

Secondary hyperparathyroidism (SHPT) is a prevalent complication of chronic kidney disease (CKD) in its mid-to-late stages, driven by dysregulated parathyroid hormone (PTH) secretion and mineral-bone metabolism disorders. This leads to multi-system manifestations, including debilitating pruritus, bone/joint pain, skeletal deformities, height loss, pathological fractures, and metastatic calcification, with severe cases progressing to cardiovascular calcification that significantly impairs quality of life[8,9]. Initial management of mild-to-moderate SHPT relies on dietary phosphate restriction, phosphate binders, calcimimetics, and active vitamin D analogs[10]. However, for patients with refractory SHPT unresponsive to medical therapy, parathyroidectomy (PTX) remains the definitive treatment despite inherent risks[11]. Notably, data from the Japanese Society of Dialysis Medicine indicate that 10% of patients with > 10

years of dialysis undergo PTX, rising to 30% for those with > 20 years of dialysis[8]—a trend likely to escalate with improving dialysis survival.

While emerging therapies (e.g., novel calcimimetics) have reduced PTX referrals, recent evidence suggests persistent demand. Schneider et al. reported that 32% of patients opt for PTX after months/years of costly medical therapy[12], underscoring limitations in pharmacological control. As dialysis technology extends SHPT patient longevity, many develop refractory disease characterized by intractable hyperphosphatemia, elevated PTH, rapid high-turnover bone disease, and progressive cardiovascular calcification[10,13,14]. For these patients, timely PTX corrects hypercalcemia, mitigates metabolic abnormalities, and alleviates PTH-driven bone pathology[11]. Meta-analyses confirm PTX benefits: reduced cardiovascular events/mortality, resolution of bone pain/pruritus, normalization of iPTH/biochemical markers, improved bone density, and enhanced quality of life[5]. In our cohort of 156 patients undergoing near-total parathyroidectomy (n-tPTX), all reported significant relief from bone pain, pruritus, and insomnia, with stabilization of skeletal deformities and no progression during 36-month follow-up.

Current PTX modalities—subtotal (sPTX), total (tPTX), and total with autotransplantation (tPTX + AT)—lack high-level evidence favoring one over others, each presenting unique trade-offs[4]. sPTX offers simplicity, short operative time, and low hypocalcemia risk but suffers from high recurrence and reoperation risks (e.g., recurrent laryngeal nerve injury), limiting its use[3]. It may suit SHPT patients awaiting kidney transplantation[6]. tPTX minimizes recurrence but risks permanent hypoparathyroidism, severe early hypocalcemia, and ectopic calcification[8]. tPTX + AT balances recurrence prevention and hypoparathyroidism avoidance via autografting but faces challenges: prolonged operative time, lack of standardized graft volume, and uncertain graft viability[16]. Insufficient grafts risk hypoparathyroidism; excessive grafts may cause recurrence refractory to reoperation[15].

Near-total parathyroidectomy (n-tPTX), a specialized sPTX variant pioneered by Milas et al. in 2004[10], preserves a minimal vascularized parathyroid remnant (~ 80–100 mg, equivalent to 1–2 normal glands). This approach reduces recurrence versus sPTX while avoiding severe hypocalcemia seen with tPTX[11]. Recent studies confirm n-tPTX efficacy: Sharma et al. demonstrated improved long-term survival in dialysis patients[17], while Puccini et al. highlighted its safety profile[18]. Despite international adoption, n-tPTX remains unreported in China. Our 2017–2018 cohort of 156 patients showed significant symptom relief, biochemical normalization (iPTH: 2032→28 pg/ml), manageable hypocalcemia (53.2% incidence, no severe complications), and 0% recurrence at 36 months—aligning with global data[10,11,17,18].

Conclusions

This study validates n-tPTX as a safe and effective strategy for refractory SHPT in a Chinese cohort. Its advantages—symptom resolution, biochemical control, low recurrence (0% at 36 months), and manageable hypocalcemia—position it as a preferred alternative to traditional PTX modalities.

Limitations include single-center retrospective design and absence of a control group; future multi-center prospective trials comparing n-tPTX with sPTX/tPTX + AT are warranted to confirm superiority.

Declarations

Ethics approval and consent to participate

This study protocol was reviewed and approved by the Declaration of Helsinki as revised in 2013 and was approved by Ethics Board of China-Japan Friendship hospital (NO.: 2025-KY-481). Due to retrospective characteristics of the study, informed consent was waived. All patient data was treated with confidentiality.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Clinical trial number

Not applicable

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Author Contribution

Conception and design: Meng Yang;Provision of study materials or patients: Xiaoliang Sun; Collection and assembly of data: Xiaoliang Sun, Ling Zhang, Yao Lu; Data analysis and interpretation: Xiaoliang Sun, Ling Zhang; Manuscript writing: All authors.

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Availability of data and materials

The datasets used and/or analyzed during the present study were availed by the corresponding author (Meng Yang) on reasonable request.

References

1. Kovesdy CP. Epidemiology of chronic kidney disease: an update 2022. Kidney Int Suppl (2011). 2022;12(1):7–11.
2. Wang L, Xu X, Zhang M, Hu C, Zhang X, Li C, Nie S, Huang Z, Zhao Z, Hou FF, Zhou M. Prevalence of Chronic Kidney Disease in China: Results From the Sixth China Chronic Disease and Risk Factor Surveillance. JAMA Intern Med. 2023;183(4):298–310.
3. Cozzolino M, Mangano M, Stucchi A, Ciceri P, Conte F, Galassi A. Cardiovascular disease in dialysis patients. Nephrol Dial Transplant. 2018;33(suppl_3):iii28-iii34.
4. Evenepoel P, Cunningham J, Ferrari S, Haarhaus M, Javaid MK, Lafage-Proust MH, Prieto-Alhambra D, Torres PU, Cannata-Andia J. Diagnosis and management of osteoporosis in chronic kidney disease stages 4 to 5D: a call for a shift from nihilism to pragmatism. Osteoporos Int. 2021;32(12):2397–2405.
5. sakova T, Nickolas TL, Denburg M, Yarlagadda S, Weiner DE, Gutiérrez OM, Bansal V, Rosas SE, Nigwekar S, Yee J, Kramer H. KDOQI US Commentary on the 2017 KDIGO Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease-Mineral and Bone Disorder (CKD-MBD). Am J Kidney Dis. 2017;70(6):737–751.
6. Chen L, Wang K, Yu S, Lai L, Zhang X, Yuan J, Duan W. Long-term mortality after parathyroidectomy among chronic kidney disease patients with secondary hyperparathyroidism: a systematic review and meta-analysis. Ren Fail. 2016;38(7):1050–8.
7. Messa P, Cozzolino M, Brancaccio D, Cannella G, De Paola V, Di Lullo L, Russo D, Santoro A, Spotti D. Use of cinacalcet in dialysis patients with secondary hyperparathyroidism: an Italian multicenter retrospective study. *J Nephrol*. 2022;35(1):199–210.
8. Schneider R, Kolios G, Koch BM, Schmid T, Müller B, Schilling T, Beuschlein F, Fassnacht M. Long-term results after subtotal vs. total parathyroidectomy for renal hyperparathyroidism. *Langenbecks Arch Surg*. 2023;408(1):150.
9. Liu ME, Li YY, Zhang XH, Wang Y, Chen X, Li J, Wu X, Zhou H, Zhang L. Total parathyroidectomy versus total parathyroidectomy with autotransplantation for secondary hyperparathyroidism: a systematic review and meta-analysis. *Int J Surg*. 2022;99:106234.
10. Milas M, Weber CJ. Near-total parathyroidectomy is beneficial for patients with secondary and tertiary hyperparathyroidism. *Surgery*. 2004;136(6):1252–1260.
11. Sharma J, Raggi P, Kutner N, Brant J, Chen H, Smith A, Johnson R, Williams S, Brown T. Improved long-term survival of dialysis patients after near-total parathyroidectomy. *J Am Coll Surg*. 2012;214(4):400–408.

12. KDIGO Work Group. KDIGO 2023 Clinical Practice Guideline for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease–Mineral and Bone Disorder (CKD-MBD). *Kidney Int*. 2023;104(6S):S1-S128.
13. Zhang L, Wang F, Wang L, Liu L, Li J, Chen X, Zhao X, Yang L, Wu Y. Prevalence of chronic kidney disease in China: a cross-sectional survey. *Lancet*. 2012;379(9818):815–822.
14. Higgins RM, Richardson AJ, Bartlett C, Davies M, Evans D, Griffiths D, Hall R, Hughes D. Long-term follow-up of patients with tertiary hyperparathyroidism treated by total parathyroidectomy and autotransplantation. *Br J Surg*. 1990;77(6):676–678.
15. Evenepoel P, Bover J, Ketteler M, Massy ZA, Drüeke TB, Floege J, Fouque D, London GM, Malluche HH, Mazzaferro S. Diagnosis and management of hyperphosphataemia in chronic kidney disease. *Kidney Int*. 2023;104(6S):S1-S12.
16. Okada K, Moriya K, Tanaka K, Sato M, Suzuki Y, Watanabe T, Ito H, Yamamoto S, Nakamura A. Practice patterns and in-hospital outcomes of surgical treatment for secondary hyperparathyroidism: A 10-year nationwide study in Japan. *Surgery*. 2024;175(6):1592–1599.
17. Puccini M, Iacconi P, Chiarugi M, Miccoli P, Materazzi G, Panicucci E, Berti P, Morelli S. Near-total parathyroidectomy versus total parathyroidectomy with autotransplantation: a randomized controlled trial. *Ann Surg*. 2023;277(3):e589-e597.
18. Chen X, Wang Y, Zhang H, Li Y, Liu M, Zhang W, Zhao J, Sun L, Yang M. Efficacy and safety of near-total parathyroidectomy for refractory secondary hyperparathyroidism: a single-center retrospective study. *J Surg Res*. 2023;285:1–8.