RESEARCH ARTICLE

# Correlation of preoperative localisation of parathyroid adenoma with imaging findings and surgical outcome

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## Abstract

**Objective:** To assess the outcomes of parathyroidectomy in primary hyperparathyroidism with or without preoperative imaging localisation, and to evaluate the association with surgical cure.

**Method:** The retrospective cohort study was conducted from August 2022 to January 2023 at the Aga Khan University Hospital, Karachi, and comprised records of all adult primary hyperparathyroidism patients who underwent parathyroidectomy between January 2011 and December 2021. Demographic, surgical and outcome data was recorded. Imaging data included sestamibi scan and ultrasound. Cure was defined as normalisation of calcium and parathyroid hormone levels postoperatively and at two-week follow-up. Data was analysed using SPSS 19.

**Results:** Of the 140 patients with mean age 48.23±15.1 years, 100(71.4%) were female. Most patients had a single adenoma 129(92.1%). Unilateral neck exploration was performed in 95.7% patients. Cure rates were highest in dual localised cases involving both ultrasound and sestamibi scan 90.3% compared to 70.7% for those with only sestamibi scan, and 89.7% for ultrasound-only localisation.

**Conclusion:** Preoperative ultrasound positivity was associated with high cure rate after parathyroidectomy for primary hyperparathyroidism. Dual positive imaging with both ultrasound and sestamibi scans demonstrated a numerically high cure rate, supporting the use of ultrasound as the first localisation modality and sestamibi scan as an adjunct when ultrasound is inconclusive.

**Keywords:** Adenoma, Hypercalcemia, Parathyroid carcinoma, Primary hyperparathyroidism. (JPMA 76: 1267; 2026)

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## Introduction

Primary hyperparathyroidism (PHPT) is the third most common endocrine disorder, and it is often responsible for hypercalcaemia. The prevalence of this condition may vary depending on gender and race.[1] Around 80% of PHPT cases are caused by a single adenoma, while the remainder can be attributed to multiple gland diseases that can arise from hyperplasia or multiple adenomas.[2] Parathyroid carcinoma (PTC) accounts for <1% of PHPT cases.[3] To diagnose PHPT, a comprehensive biochemical and hormonal evaluation is essential, while imaging studies are primarily used to localise the abnormal parathyroid gland and guide surgical planning.[4] Ultrasonography (USG) and sestamibi scanning are localisation imaging modalities used in patients with confirmed PHPT, primarily to identify abnormal parathyroid glands and assist in surgical planning, rather than for establishing the diagnosis itself.[5] USG has a sensitivity rate ranging 70-80%, with a reported specificity level of 90%.[6] On the other hand, sestamibi scans have been recorded to have sensitivity levels ranging 72-100%.[7,8]

Parathyroidectomy is the sole conclusive treatment for PHPT.[9] As a standard, patients who are deemed suitable candidates for surgical intervention typically undergo preoperative work to locate the adenoma and determine the optimal surgical approach. Successful preoperative identification of parathyroid adenoma with imaging confers several benefits, including enabling minimally invasive surgery, enhancing cure rate and minimising preoperative complications. Patients whose imaging results correspond accurately usually require only minimally invasive surgery, while those with non-concordant imaging findings may necessitate bilateral open-neck surgery.[10]

The current study was planned to assess the results of parathyroidectomy, both with and without preoperative imaging that yielded positive results, and to analyse their correlation.

## Patients and Methods

The retrospective cohort study was conducted from August 2022 to January 2023 at the Aga Khan University Hospital (AKUH), Karachi, and comprised data of all eligible adult patients who underwent parathyroidectomy for PHPT

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between January 2011 and December 2021. After approval from the institutional ethics review committee, data was retrieved from the AKUH Health Management Information System (HMIS). All consecutive patients aged ≥18 years who underwent parathyroidectomy for PHPT were included. Patients were eligible if they had complete clinical and biochemical records and at least one preoperative imaging modality (ultrasound and/or sestamibi scan) available. Patients undergoing re-operative parathyroid surgery and those with secondary or tertiary hyperparathyroidism were excluded.

Data was collected using a structured Google Form, and included demographics, laboratory results, imaging scans, surgical details and outcomes. Laboratory values were extracted from preoperative tests performed during the time of admission or closest to the date of surgery. Imaging findings were verified through a review of official radiology reports, ensuring consistency across clinical, laboratory and imaging data. Cure was defined as normalisation of calcium and parathyroid hormone (PTH) levels postoperatively and at two-week follow-up.

Data was analysed using SPSS 19. Continuous variables were presented as mean±standard deviation, while categorical variables were presented as frequencies and percentages. The association of cure rate with preoperative imaging, age and gender was assessed using a combination of chi-square tests and binary logistic regression. Chi-square tests of independence were applied to examine whether cure rates differed across categorical variables, including USG of the neck, sestamibi scan, and combined imaging positivity, as both the outcome (cure: yes/no) and predictors were categorical. A binary logistic regression was performed to evaluate the effect of continuous (age) and categorical (gender) predictors on cure rate, providing odds ratios (ORs) with 95% confidence intervals (CIs) to quantify the strength of association. Gender was omitted from regression analysis due to perfect collinearity, and a complementary chi-square test was used to assess its association with cure rate. P<0.05 was considered statistically significant.

## Results

Of the 140 patients with mean age 48.23±15.1 years, 100(71.4%) were female. The mean preoperative corrected calcium and mean preoperative PTH was 11.41±1.19mg/dl and 614.50±658.8pg/ml, respectively. The mean serum vitamin D level was 21.33±21.17IU (Table 1). Unilateral neck exploration was performed in 134(95.7%) patients. Most patients had a single adenoma 129(92.1%), followed by 9(6.4%) cases of double adenoma, 1(0,71%) case of four-gland hyperplasia, and 1(0.71%) case of ectopic gland (Figure 1).

USG data were available for 137(97.8%) patients, and cure rates differed significantly across USG categories ($p$=0.006). Sestamibi scans were available for 136(97.14%) patients, and cure rates did not differ significantly across categories ($p$=0.365). Patients with both imaging modalities positive demonstrated a high numerical cure rate, but this was not statistically significant ($p$=0.109). While at least one imaging modality was available for all included patients, some had missing data for either the ultrasound or the sestamibi scan; these cases were categorized as "not available" in modality-specific analyses. The "not available" category was

**Table-1:** Characteristics of the study population (n=140).

| Parameters | n (%) |
|---|---|
| **Gender** | |
| Female | 100 (71.4) |
| Male | 40 (28.6) |
| Mean preoperative corrected calcium (mg/dl) | 11.41±1.19 |
| Mean preoperative PTH (pg/ml) | 614.50±658.8 |
| Median preoperative PTH (pg/ml) | 303.50 |
| Minimum preoperative PTH (pg/ml) | 29.0 |
| Maximum preoperative PTH (pg/ml) | 2500 |
| Mean serum vitamin D (IU) | 21.33±21.17 |

PTH: parathyroid hormone.

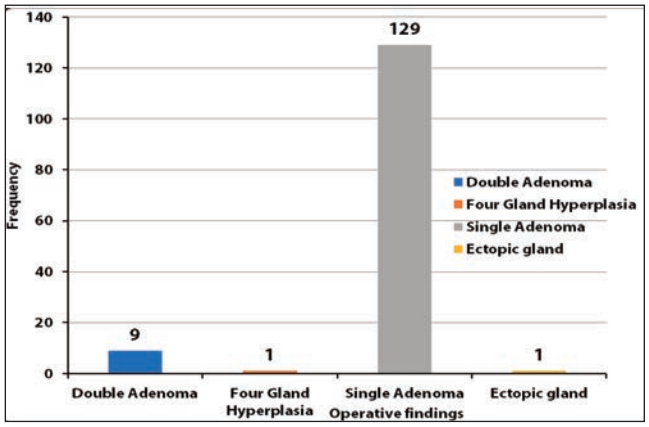


**Figure:** Distribution of operative findings.

**Table-2:** Association of preoperative imaging with cure rate.

| Imaging Type | Category | Not Cured (n) | Cured (n) | Total (n) | Cure Rate (%) | Pearson $\chi^2$ | $p$-value |
|---|---|---|---|---|---|---|---|
| **Ultrasound** (US) | Negative | 2 | 12 | 14 | 85.7 | 10.36 | 0.006* |
| | Not available | 11 | 23 | 34 | 67.6 | | |
| | Positive | 8 | 81 | 89 | 91.0 | | |
| **Sestamibi scan** | Negative | 0 | 8 | 8 | 100 | 2.01 | 0.365 |
| | Not available | 3 | 22 | 25 | 88.0 | | |
| | Positive | 18 | 85 | 103 | 82.5 | | |
| **both imaging positive** | — | 6 | 56 | 62 | 90.3 | 2.574 | 0.109 |

**Table-3:** Association of age and gender with cure rate.

| Variable | Measure | Estimate / OR | 95% CI | *p*-value |
|---|---|---|---|---|
| Age (years) | Logistic regression (OR) | 1.01 | 0.98 – 1.04 | 0.542 |
| Gender | Logistic regression (OR) | Omitted* | — | — |
| | Chi-square test (Cure rate) | — | — | 0.982 |
| Female (=0) | Cure / Total (%) | 84 / 99 (84.8%) | — | — |
| Male (=1) | Cure / Total (%) | 34 / 40 (85.0%) | — | — |

OR: Odds ratio, CI: Confidence interval.

**Table-4:** Association of clinical characteristics with cure rate.

| Parameter | **Cured** (n=119) | **Not cured** (n=21) | *p*-value |
|---|---|---|---|
| Mean Age (years) | 48.5±15.4 | 46.33±23.8 | 0.53 |
| Gender | | | 0.9 |
| Male | 34 | 6 | |
| Female | 85 | 15 | |
| Preoperative serum calcium | 11.2±1.1 | 10.8±1.0 | 0.02 |
| Preoperative PTH (pg/ml) (Median IQR) | 292 (180-794) | 641 (227.5-10886) | 0.06 |
| Pre-operative Vit D (Median IQR) | 16.9 (10.5-26.2) | 14.4 (5.8-25.3) | 0.34 |

PTH: parathyroid hormone, IQR: Interquartile range.

retained in the analysis to avoid unnecessary exclusion of patients and to reflect real-world clinical practice. (Table 2).

Age was not significantly associated with cure rate (OR: 1.01, 95% CI: 0.98-1.04, p=0.542). Gender was not significant associated with cure rate (*p*=0.982) (Table 3)

There was a significant association between preoperative serum calcium and cure rate (*p*=0.02) (Table 4).

## Discussion

The results of the current study align with earlier research. Chander et al. documented high cure rates in patients with dual localisation, supporting the clinical importance of concordant imaging in guiding minimally invasive surgery.[11] Several studies have demonstrated that ultrasound alone, when performed and interpreted by experienced operators, can localise parathyroid adenomas with very high accuracy and lead to excellent surgical outcomes.[12,13] For instance, Irvin et al. documented that minimally invasive parathyroidectomy guided exclusively by positive high-resolution USG achieved a cure rate of 99.2% in a large cohort of patients.[12] Solorzano et al. reported that a surgeon-performed USG had superior localisation accuracy compared to sestamibi scan, resulting in low surgical failure rates.[14] Studies have found that USG was more sensitive than sestamibi scintigraphy, but using both together resulted in better performance than either alone.[15,16] Morever sestamibi scintigraphy has been shown to detect ectopic parathyroid adenomas in 88% of unselected patients, demonstrating a superior detection rate compared to USG for ectopic lesions.[17]

The current study has limitations as it had a single-centre, retrospective design, which has reduced the generalisability of the findings. Besides, certain sub-groups, such as patients with negative imaging, comprised very few cases, potentially affecting statistical power. Furthermore, follow-up was confined to early postoperative biochemical normalisation, missing the late recurrence of hyperparathyroidism.

Large-scale, multicentre, prospective studies with longer follow-up are recommended.

## Conclusion

Preoperative USG positivity was associated with the highest cure rate after parathyroidectomy for PHPT. Dual positive imaging with both ultrasound and MIBI scan also showed high cure rates.

**Disclaimer:** None.

**Conflict of Interest:** None.

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**Author Contribution:**

**AJ:** Concept, methodology, data curation and writing original draft.
**NR:** Data analysis, formal analysis, writing, review and editing.
**UK:** Investigation, patient data collection and imaging analysis.
**FK:** Validation and supervision.
**NI:** Concept, project administration, surgical outcomes analysis.