

The Parathyroid Puzzle: Mapping Adenomas Over Four Years

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ABSTRACT

Background: Primary hyperparathyroidism (PHPT) is most commonly caused by a solitary parathyroid adenoma. While preoperative imaging has enabled focused parathyroidectomy, intraoperative decision-making in cases of inconclusive localisation still relies heavily on understanding the typical anatomical distribution of adenomas.

Objective: To analyze the anatomical distribution of solitary parathyroid adenomas over a four-year period and identify the most common site.

Methods: This retrospective observational study reviewed 261 patients who underwent parathyroidectomy for PHPT between January 2021 and April 2025 at the Endocrine and Breast Division, Department of General Surgery, SKIMS. Patients with a single adenoma confirmed on imaging and histopathology were included. The location of each adenoma was recorded based on operative findings.

Results: Of the 261 patients (183 females, 78 males; mean age: 32 years), the right inferior parathyroid gland was the most common site of adenoma (45.6%), followed by the left inferior gland (42.1%). Superior gland adenomas were less frequent (left: 5.7%, right: 5.0%). Ectopic adenomas were identified in 1.6% of cases.

Conclusion: The inferior parathyroid glands—particularly the right—are the most frequent sites of solitary adenomas. In cases with inconclusive imaging, initial surgical exploration should focus on the inferior glands. These findings support a strategic approach to focused parathyroidectomy and may help reduce operative time and morbidity.

Keywords: Primary Hyperparathyroidism, Parathyroid Adenoma, Superior Parathyroid, Ectopic Parathyroid

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INTRODUCTION

Primary hyperparathyroidism (PHPT) is a clinical disorder characterized by an increased level of parathyroid hormone (PTH), which may be caused by an adenoma (solitary or multiple), idiopathic hyperplasia, or parathyroid carcinoma¹. Current data suggests a prevalence of 1-4/1000 in the general population; most are diagnosed between 50 and 60 years of age, and women are twice as likely to be affected as men^{2,3}.

The underlying aetiology of PHPT is usually a solitary parathyroid adenoma in 85% of the cases; however, in a small number of patients (2–4%), there are double adenomas. Traditionally, open bilateral exploration and exposure of all 4 glands was considered the gold standard until the 1990s, as multiglandular hyperplasia was identified in up to 15% to 25% of patients⁴. Improvements in the quality of localisation studies with experience in ultrasonography and its combination with 99mTc-

SestaMIBI (with or without single-photon emission computed tomography) allowed the localisation of a parathyroid adenoma to be accurate enough to permit focused parathyroidectomy, targeting only the gland identified on preoperative imaging 5. 99mTc-sestamibi scan, ultrasonography, computed tomography, and magnetic resonance imaging (MRI) have been used for this purpose.

In certain cases, bilateral neck exploration may be avoided even when preoperative localisation of the adenoma is unsuccessful. This can be achieved by initiating surgery at the most common site for parathyroid adenomas and utilising intraoperative PTH monitoring to confirm successful removal. Unfortunately, there is a lack of consensus as to the distribution of solitary adenomas over

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the parathyroid gland⁶.

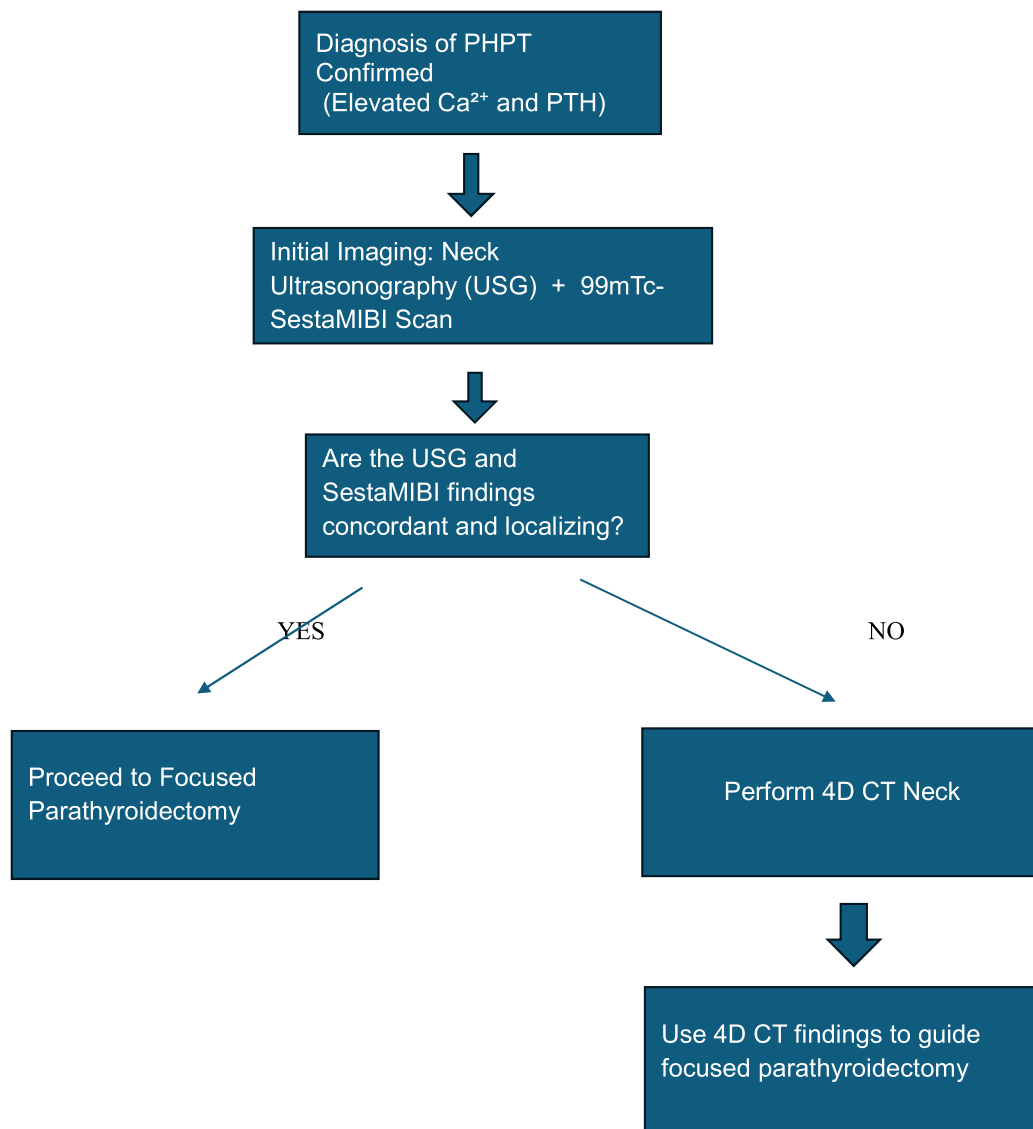
MATERIAL AND METHODS

This is a retrospective observational study done in the Endocrine and Breast division of the department of General Surgery, SKIMS, by reviewing data of 261 patients who underwent parathyroidectomy for primary hyperparathyroidism (PHPT) from January 2021 to April 2025. The operative notes of the 261 patients were reviewed, and the location of the adenoma was noted.

The diagnosis of PHPT was made by increased levels of serum calcium (more than 10 mg/dl) and increased PTH (more than 65 pg/ml), with confirmation of the parathyroid

adenoma by imaging. The imaging used for localisation of parathyroid adenoma included Ultrasonography of the neck (Figure 1) and 99mTc-SestaMIBI scan. If the two imaging modalities were concordant, no other imaging was done. In case of non-concordant or non-localisation, a 4D CT scan of the neck (Figure 2) was used in selective cases⁷. Parathyroidectomy was done using the focused parathyroidectomy approach. The diagnosis of parathyroid adenoma (Figure 3) was confirmed on histopathology.

Descriptive statistics were used to summarise the data. Frequencies and percentages were calculated to determine the distribution of solitary parathyroid adenomas by gland location. Microsoft Excel was used for data analysis.



Inclusion and exclusion criteria

All patients with a diagnosis of PHPT with a single adenoma on imaging were included. Patients with more than one adenoma or parathyroid hyperplasia were excluded.

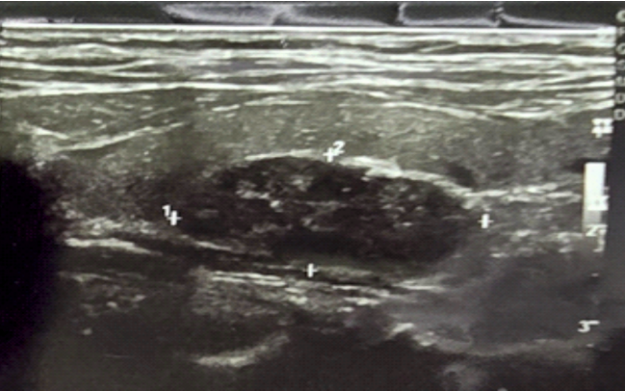


Fig. 1 : Parathyroid adenoma on USG : Ultrasound image demonstrates a well-defined, oval, hypoechoic lesion located posterior and inferior to the thyroid lobe.

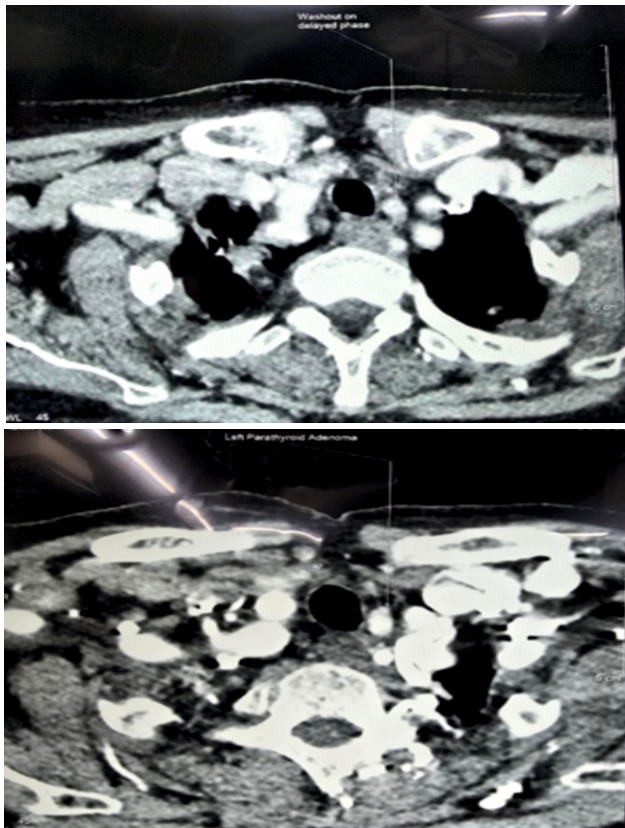


Fig. 2 : 4D CT scan showing left inferior parathyroid adenoma : 4D CT reveals an avidly enhancing, well-circumscribed ovoid lesion located posterior to the left thyroid lobe. The lesion demonstrates rapid contrast uptake

in the arterial phase and washout in the delayed phase, typical of parathyroid adenoma.

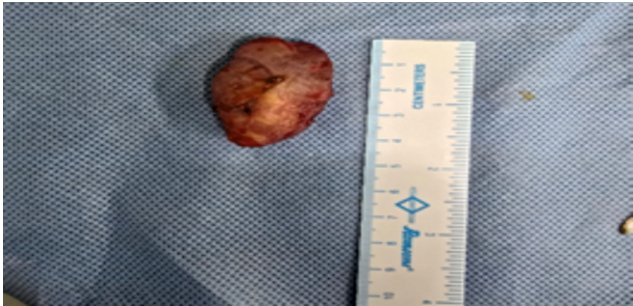


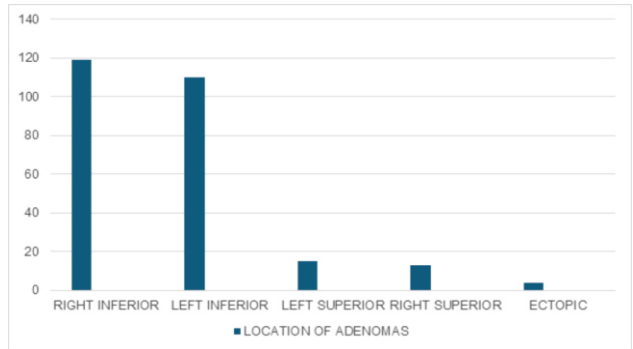
Fig. 3 : Parathyroid Adenoma Specimen

RESULTS

Among the 261 patients evaluated, 183 were female and 78 were male, with ages ranging from 21 to 67 years and a mean age of 43.75 years. All patients underwent single-gland parathyroidectomy. Adenoma removal was confirmed and subsequently verified on final histopathology.

Among the 261 patients with a single parathyroid adenoma, the most common location was the right inferior parathyroid gland, identified in 119 (45.6%) patients. The left inferior gland was the site in 110 (42.1%) patients, being the 2nd most common site. The remaining adenomas were in the left superior gland in 15 (5.7%) patients and the right superior gland in 13 (5.0%) patients. Additionally, four ectopic adenomas (1.6%) were identified—one in the left paraesophageal groove and three in the mediastinum. (Figure 4, Table 1).

SITE	NUMBER	PERCENTAGE
Right Inferior	119	45.6%
Left Inferior	110	42.1%
Left Superior	15	5.7%
Right Superior	13	5.0%
Ectopic	4	1.6%



DISCUSSION

Although preoperative localisation techniques for parathyroid adenomas in primary hyperparathyroidism are generally effective, imaging fails to localise the adenoma or yields false-negative results in approximately 10% of cases^{8,9}. Failure of localisation needs bilateral exploration, which has its disadvantages. The focused approach is the most used method for well-localised parathyroid adenomas. We performed focused parathyroidectomy in most cases. In our study, 261 patients with well-localised parathyroid adenomas were reviewed to find the most common location. Our study shows that the right inferior parathyroid site is the common location for adenoma. The left inferior parathyroid is the second most common site for adenoma, as per our study. Both right and left superior parathyroid adenomas were found in fewer cases.

In cases where preoperative imaging does not successfully localise the parathyroid adenoma, knowledge of the most common sites can be valuable. Surgeons may begin exploration at the inferior parathyroid glands, where there is approximately a 44% likelihood of locating the adenoma. This approach has the potential to decrease both operative time and surgical morbidity. So, the most common site to start should be the inferior parathyroids as per our study.

Some studies have tried to find the location of parathyroid adenoma. Hamidi and colleagues conducted a study of 118 patients to determine the distribution of solitary parathyroid adenomas⁶. This group concluded that the distribution of adenomas over the superior and inferior parathyroid glands showed a significantly higher incidence of adenoma in the lower parathyroid glands ($p < .001$). However, the right-to-left distribution of adenomas was not significant ($p = .4$).

Marzouki et al conducted a study of 121 patients to determine the most common location of parathyroid adenomas. They found that the left inferior parathyroid glands were the most common site of adenomas, followed by the right inferior parathyroid glands¹⁰.

This retrospective analysis revealed that the right inferior parathyroid gland was the most frequent location of adenomas in our patient cohort. This insight can guide parathyroid surgeons in cases where preoperative imaging is inconclusive, offering a logical starting point for exploration. When combined with intraoperative PTH monitoring¹¹, this strategy may facilitate a minimally

invasive approach. Future research should focus on patients with non-localised adenomas in the preoperative period to assess adenoma distribution and evaluate whether these findings align with the trends observed in our study.

CONCLUSION

The inferior parathyroid glands—particularly the right—are the most frequent sites of solitary adenomas. In cases with inconclusive imaging, initial surgical exploration should focus on the inferior glands. These findings support a strategic approach to focused parathyroidectomy and may help reduce operative time and morbidity.

Conflict of Interest: None

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Written informed Consent: Taken

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