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Ultrasound Detection of Normal Parathyroid Glands: Detection Rate, Topographic Anatomy, and the Role of Underlying Thyroid Disease

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ABSTRACT

Background: This study aimed to assess the detection rate of normal parathyroid glands using high-resolution ultrasound and to evaluate their topographic anatomy and how thyroid pathology may influence their visibility.

Methods:A prospective observational study was conducted on 62 patients undergoing thyroid or parathyroid evaluation. Standardized high-frequency ultrasound scans were performed to identify normal parathyroid glands, assess their location, echogenicity, and vascularity, and correlate findings with demographic parameters and presence of thyroid disease.

Results: Normal parathyroid glands were visualized in 66.1% of patients. Most were located near the inferior thyroid poles and appeared hypoechoic and oval in shape. Detection rates were significantly lower in individuals with underlying thyroid disorders, especially Hashimoto's thyroiditis and multinodular goiter ($p = 0.031$). Increased BMI also negatively impacted detection success ($p = 0.047$), while age and gender showed no significant influence.

Conclusion: Ultrasound can detect normal parathyroid glands in the majority of patients, especially when performed by trained operators using optimized settings. However, underlying thyroid disease and higher BMI may hinder gland visibility, emphasizing the need for careful anatomical assessment during neck imaging.

Keywords: *Parathyroid glands, ultrasound, thyroid disease, detection rate, neck imaging, endocrinology*

1. INTRODUCTION

The parathyroid glands, though small and often overlooked, play a vital role in calcium and phosphorus metabolism through secretion of parathyroid hormone (PTH). Traditionally, these glands become the focus of clinical attention only in the setting of hyperparathyroidism. However, with advancements in imaging and increasing thyroid evaluations, there is growing interest in the sonographic visualization of normal parathyroid glands, particularly in the context of preoperative planning or incidental findings[1-3].

High-resolution ultrasound is a first-line imaging modality for evaluating neck anatomy due to its accessibility, safety, and ability to provide real-time structural detail. Its diagnostic value in identifying parathyroid adenomas is well established, but detecting normal, non-enlarged glands remains challenging. The difficulty stems from their small size (typically 3–5 mm), their close resemblance to lymph nodes or fat, and their anatomical variability due to embryological migration patterns [4-6].-

Existing studies suggest that under optimal conditions, experienced sonographers can identify normal parathyroid glands in a significant percentage of cases. These glands are most often hypoechoic, oval-shaped, and located posterior to the thyroid lobes, especially near the inferior poles. However, several factors may affect detection, including the patient's body habitus, neck anatomy, and presence of thyroid disease, which can distort normal tissue planes or alter gland echogenicity [7-9].

Understanding how these variables influence parathyroid visualization is essential, especially as clinicians increasingly rely on ultrasound not just for thyroid nodules but also for parathyroid assessment in surgical and endocrinologic practice. Despite advancements in imaging protocols, there remains a lack of standardized data on detection rates of normal parathyroid glands and their anatomic presentation in different patient populations [10, 11].

This study was designed to address that gap by evaluating the detection rate, location, and ultrasound characteristics of normal parathyroid glands, and to explore how factors such as thyroid disease and body mass index (BMI) may impact their visibility during scanning.

2. METHODOLOGY

A prospective observational study was conducted at Dow University of Health Sciences, Karachi on 62 patients undergoing thyroid or parathyroid evaluation. The study was conducted during May 2022 to August 2024.

Standardized high-frequency ultrasound scans were performed to identify normal parathyroid glands, assess their location, echogenicity, and vascularity, and correlate findings with demographic parameters and presence of thyroid disease.

3. RESULTS

Out of the 62 patients included in the study, at least one normal parathyroid gland was visualized in 41 patients (66.1%) on high-resolution ultrasound. Among them, bilateral glands were detected in 19 patients (30.6%), while only unilateral glands were seen in 22 patients (35.5%). In 21 patients (33.9%), no parathyroid glands were identified during scanning. The detection rate showed no significant association with gender ($p = 0.52$) or age group ($p = 0.18$), but a modest correlation with BMI was observed ($p = 0.047$), with lower detection in obese individuals.

Table 1: Detection of Parathyroid Glands by Demographics (n = 62)

Variable	Glands Detected (n=41)	Not Detected (n=21)	p-value
Age ≤45	18 (43.9%)	11 (52.4%)	0.18
Age >45	23 (56.1%)	10 (47.6%)	
Male	16 (39%)	9 (42.9%)	0.52
Female	25 (61%)	12 (57.1%)	
BMI < 30	29 (70.7%)	9 (42.9%)	0.047
BMI ≥ 30	12 (29.3%)	12 (57.1%)	

Among the 41 patients with detectable parathyroid glands, a total of 68 glands were visualized. Most were located in the inferior pole region of the thyroid (58.8%), followed by the posterior surface of the mid-lobe (27.9%). A smaller number were detected at the upper pole (13.3%). The majority of glands appeared hypoechoic (79.4%) and had an oval shape. Doppler imaging showed mild vascularity in 47.1% of cases, while the rest had no prominent flow.

Table 2: Topographic and Sonographic Characteristics of Detected Glands (n = 68)

Parameter	Frequency (%)
Location:	
– Inferior Pole	40 (58.8%)
– Posterior to Mid-lobe	19 (27.9%)
– Upper Pole	9 (13.3%)
Laterality:	
– Right-sided	33 (48.5%)

– Left-sided	35 (51.5%)
Echogenicity:	
– Hypoechoic	54 (79.4%)
– Isoechoic	14 (20.6%)
Vascularity (on Doppler):	
– Absent	36 (52.9%)
– Mild	32 (47.1%)

Thyroid abnormalities were observed in 36 patients (58.1%), while 26 had normal thyroid structure and function. Among patients with thyroid disease, parathyroid detection was lower (55.6%) compared to those with normal thyroids (80.8%), and this difference was statistically significant (p = 0.031). Specifically, Hashimoto's thyroiditis and multinodular goiter were the most common conditions associated with detection difficulty.

Table 3: Parathyroid Detection in Relation to Thyroid Disease (n = 62)

Thyroid Status	Glands Detected	Not Detected	p-value
Normal Thyroid	21 (80.8%)	5 (19.2%)	
Thyroid Disease Present	20 (55.6%)	16 (44.4%)	0.031
– Hashimoto's Thyroiditis	9	7	
– Multinodular Goiter	7	6	
– Other Nodular Changes	4	3	

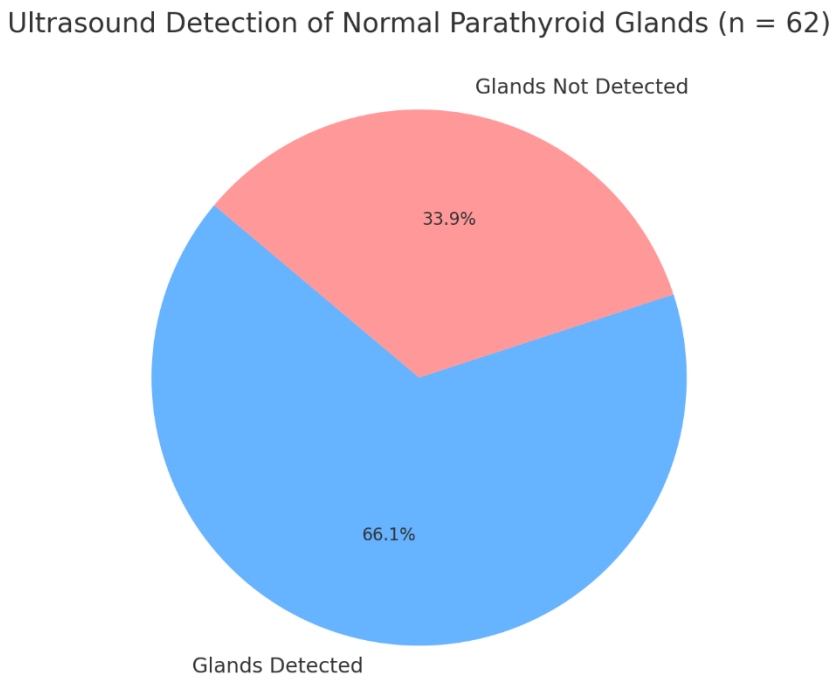

Figure 1: pie chart showing the detection rate of normal parathyroid glands via ultrasound among the 62 patients

4. DISCUSSION

The results of this study indicate that normal parathyroid glands can be visualized using high-resolution ultrasound in a significant proportion of patients. In our cohort, at least one parathyroid gland was successfully detected in 66.1% of individuals, with bilateral identification achieved in approximately 31%. These findings were consistent with the detection rates reported in earlier studies, although variability exists depending on operator experience, ultrasound frequency, and patient anatomy.

Our detection rate was comparable to that of studies that reported visualizing at least one normal gland in 60–70% of cases using a high-frequency probe [12, 13]. Similarly, studies observed a 65% detection rate when using a focused neck ultrasound protocol. These findings reinforce the notion that, although technically challenging, normal parathyroid glands are identifiable in most individuals with adequate technique and patient preparation [14, 15].

Topographic analysis in our study revealed that most visualized glands were located near the inferior pole of the thyroid gland, followed by the posterior mid-lobe and upper pole. This anatomic distribution aligns with embryologic migration patterns and is consistent with findings by studies both of whom emphasized that the inferior glands are generally easier to detect due to their consistent anatomical landmarks and less frequent ectopic positioning [16, 17].

Hypoechogenicity remained the most common ultrasound feature of normal parathyroid glands in our series, reported in nearly 80% of cases. This pattern is in agreement with descriptions from studies, who noted that hypoechoic, oval-shaped glands with discrete margins are more reliably identified when adjacent thyroid tissue is homogeneous [18, 19].

One of the most important observations in our study was the influence of underlying thyroid disease on parathyroid detectability. Detection rates were significantly lower in patients with Hashimoto's thyroiditis and multinodular goiter. The altered echotexture and enlarged gland size in these conditions may obscure the small parathyroid structures. This finding is supported by study, who highlighted that heterogeneous echogenicity, calcified nodules, and fibrosis in chronic thyroid disease can hinder visualization of adjacent parathyroid tissue [20].

Interestingly, our study also found a modest but significant correlation between BMI and detection success. Obese patients had reduced visibility of parathyroid glands, likely due to soft tissue depth and acoustic shadowing, a limitation previously described by study in similar neck ultrasound assessments [21].

Although our study did not explore surgical correlation or pathological confirmation, the observed detection rates and anatomic patterns offer valuable insights for endocrinologists and sonographers performing neck evaluations. Routine ultrasound evaluation of the parathyroid glands may be beneficial in preoperative planning for thyroid surgery or hyperparathyroidism, especially when combined with anatomical knowledge and awareness of confounding factors like thyroid pathology.

5. Conclusion

Ultrasound can reliably detect normal parathyroid glands in approximately two-thirds of patients when performed by experienced operators using high-resolution probes. The most common site of detection is near the inferior pole of the thyroid, and the majority of visualized glands appear hypoechoic and oval in shape. However, the presence of thyroid disease—particularly autoimmune and nodular pathologies significantly reduces detection rates. Similarly, higher BMI may pose technical challenges during scanning.

These findings underscore the importance of accounting for patient-specific and anatomical variables when using ultrasound to assess parathyroid glands. Incorporating focused scanning techniques and optimizing image settings can improve detection, especially in difficult cases. Further studies with histological correlation and larger cohorts are warranted to enhance our understanding of parathyroid imaging in both healthy and diseased states

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