

Research Article

A Study on Solitary Nodule of Thyroid Gland: Evaluation of Risk Factors Associated With Occurrence of Malignancy, Diagnostic Modalities and Management at a Tertiary Care Hospital

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ABSTRACT

Background: A solitary thyroid nodule is a single, discrete swelling within an otherwise normal thyroid gland, encountered frequently in surgical practice. Although 80-90% of such nodules are benign, a solitary nodule carries a higher individual risk of malignancy (11-20%) than a nodule within a multinodular goitre (~5%), which makes systematic clinical, cytological and histopathological evaluation essential for rational management.

Aim: To study the incidence of malignancy in solitary thyroid nodules, to evaluate the risk factors associated with malignant transformation, and to correlate fine needle aspiration cytology (FNAC) with final histopathological examination (HPE) at a tertiary care teaching hospital.

Methods: This prospective observational study was conducted in the Department of General Surgery at a tertiary care teaching hospital over a two-year period. Seventy-nine patients above 12 years of age with a clinically palpable thyroid swelling who consented to surgical management were enrolled. Detailed history, clinical examination, thyroid function tests, ultrasonography and FNAC were performed in all patients, who subsequently underwent thyroidectomy with histopathological correlation of the resected specimen.

Results: The mean age of presentation was 42.65 ± 13.91 years (range 17-72 years), with marked female preponderance (94.94%; male:female = 1:19). Swelling of more than 24 months' duration was seen in 55.75% of patients. FNAC classified 82.28% of nodules as benign, 10.13% as suspicious of malignancy and 7.69% as suspicious follicular neoplasm. On final histopathology, colloid goitre (72.15%) was the commonest diagnosis, followed by papillary carcinoma (11.39%), lymphocytic thyroiditis (10.13%) and follicular carcinoma (6.33%); no anaplastic carcinoma was recorded. The overall malignancy rate was 17.72%, and FNAC showed a sensitivity of 91.8% and specificity of 98.3% against histopathology.

Conclusion: Solitary thyroid nodules in this cohort predominantly affected middle-aged women and were mostly benign, but nearly one in six harboured malignancy, chiefly papillary carcinoma. FNAC remains a reliable first-line triage tool, but its imperfect sensitivity for follicular lesions justifies histopathological confirmation of all resected specimens, and a low threshold for surgery in nodules with suspicious cytology or high-risk clinical features.

Keywords: Solitary Thyroid Nodule, Fine Needle Aspiration Cytology, Thyroidectomy, Histopathology, Papillary Carcinoma, Risk Factors.

INTRODUCTION

A solitary thyroid nodule is defined as a single, palpable lump arising within an otherwise unremarkable thyroid gland, discovered either incidentally or during a routine physical examination¹. It represents one of the most frequent endocrine surgical problems

encountered in clinical practice, with a prevalence that rises steadily with age; roughly half of all individuals with a palpable nodule are subsequently found, on imaging, to harbour additional non-palpable nodules². The overwhelming majority of solitary nodules, in the range of 80–90%, prove to be benign on

histological evaluation. Nevertheless, a solitary nodule confers a substantially higher individual probability of malignancy, quoted between 11% and 20%, compared with an isolated nodule discovered within a multinodular goitre, where the corresponding risk is closer to 5%¹. This differential risk is the principal reason a solitary nodule cannot be managed passively and must instead be worked up systematically. The clinical importance of accurate preoperative risk stratification lies in balancing two competing harms: subjecting a patient with an essentially benign nodule to unnecessary thyroid surgery, with its attendant risks of hypocalcaemia and recurrent laryngeal nerve injury, against delaying definitive treatment for an occult carcinoma³. Fine needle aspiration cytology (FNAC) has, over the past three decades, become the cornerstone investigation that allows this distinction to be made preoperatively, since it is minimally invasive, inexpensive and can be performed in the outpatient setting with a rapid turnaround^{4,5}. Reported sensitivity and specificity of thyroid FNAC in the published literature range widely, from 57–99% and 90–99% respectively, reflecting variation in operator experience, sampling technique and the inherent cytological overlap between follicular adenoma and follicular carcinoma, a distinction that ultimately requires assessment of capsular and vascular invasion on histopathology^{6,7}.

A number of clinical and demographic variables have been proposed as risk factors for malignancy in a solitary nodule, including younger or older extremes of age, male sex, a rapidly enlarging or very firm nodule, associated cervical lymphadenopathy, hoarseness of voice, and a family history of thyroid carcinoma⁸. Adjunctive investigations such as high-resolution ultrasonography, with assessment of nodule margins, echogenicity, microcalcification and vascularity, and serum thyroid-stimulating hormone estimation have also been used to refine the pretest probability of malignancy before FNAC is performed^{9,10}. Despite this array of tools, the definitive diagnosis continues to rest on histopathological examination of the resected specimen, against which the performance of all preoperative modalities must ultimately be validated¹¹.

Against this background, the present study was undertaken with three objectives: first, to determine the incidence of malignancy among patients presenting with a solitary thyroid nodule at a tertiary care teaching hospital; second, to identify the clinical and demographic

risk factors associated with malignant transformation in this population; and third, to correlate the diagnostic accuracy of FNAC with final histopathological examination, thereby providing locally relevant data to guide surgical decision-making in a resource-constrained rural referral setting.

MATERIALS AND METHODS

Study Design and Setting: This was a hospital-based prospective observational study conducted in the Department of General Surgery of a tertiary care teaching hospital serving a predominantly rural population, over a period of approximately two years. Institutional Ethics Committee clearance was obtained prior to commencement of the study, and written informed consent was taken from every participant before enrolment.

Study Population: Patients above 12 years of age presenting to the surgical outpatient department with a clinically palpable thyroid swelling, who were willing to undergo the complete diagnostic work-up and subsequent surgical management, were consecutively enrolled. Patients younger than 12 years, pregnant or lactating women, and those deemed medically unfit for surgery after anaesthetic evaluation were excluded. A total of 79 patients satisfying these criteria were included in the final analysis.

Clinical Work-Up: A structured proforma was used to record detailed history, including duration of swelling, associated symptoms such as dysphagia, change of voice, palpitations and weight change, and family history of thyroid disease. Clinical examination documented the size, consistency, mobility and any associated cervical lymphadenopathy. All patients underwent baseline haematological and biochemical investigations along with thyroid function tests (T3, T4 and TSH) to classify functional status as euthyroid, hypothyroid or hyperthyroid. Cervical ultrasonography was performed in all cases to characterise nodule morphology, and ultrasound-guided or palpation-guided FNAC was carried out and reported using standard cytological categories.

Surgical Management and Histopathology: The type of thyroidectomy, hemithyroidectomy, near-total or total thyroidectomy, was individualised according to nodule size, laterality, sonographic and cytological suspicion of malignancy, and intraoperative findings, in keeping with standard surgical guidelines¹. All resected specimens were sent for histopathological

examination, and the final HPE diagnosis was treated as the reference standard against which FNAC performance was assessed. Postoperative complications, including transient and permanent hypocalcaemia, recurrent laryngeal nerve injury, seroma, surgical site infection and hypertrophic scarring, were prospectively recorded during the inpatient stay and at follow-up.

Statistical Analysis: Data were entered into a master chart and analysed using SPSS software. Categorical variables are expressed as frequencies and percentages. The sensitivity, specificity, positive predictive value and negative predictive value of FNAC were calculated against histopathology as the gold standard, with a 95% confidence interval and a p-value of <0.001 considered statistically significant.

RESULTS

A total of 79 patients with thyroid swelling satisfying the inclusion and exclusion criteria underwent complete clinical, cytological and surgical work-up with histopathological correlation during the study period. The findings are summarised below.

Age Distribution

The mean age at presentation was 42.65 ± 13.91 years, with an age range of 17 to 72 years. The largest proportion of patients (54.43%) were above 41 years of age, followed by the 25–40 year group (39.24%); only 6.33% were younger than 25 years (Table 1, Figure 1).

Age Group	Number Of Patients	Percentage
< 25 Years	5	6.33%
25–40 Years	31	39.24%
> 41 Years	43	54.43%

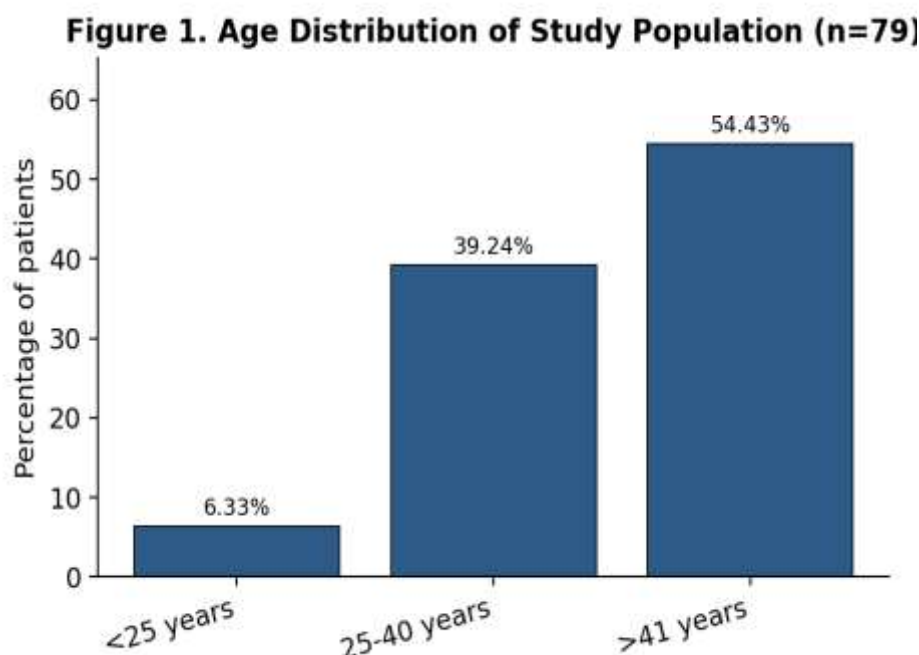


Figure 1. Age Distribution of the Study Population.

Sex Distribution

A striking female preponderance was observed, with 75 of 79 patients (94.94%) being female

and only 4 (5.06%) male, giving a female-to-male ratio of approximately 19:1 (Table 2, Figure 2).

Sex	Number Of Patients	Percentage
Male	4	5.06%
Female	75	94.94%

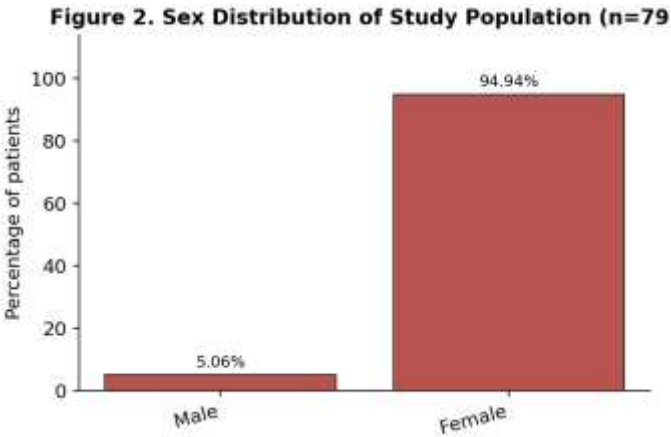


Figure 2. Sex Distribution of the Study Population.

Duration of Swelling

Swelling in the front of the neck was the presenting complaint in all patients. The duration of swelling ranged from 4 months to 7 years, with more than half of patients (55.75%) presenting after 24 months, suggesting that

most patients sought surgical attention late rather than at nodule onset (Table 3, Figure 3). Duration of swelling did not, in itself, show a significant association with malignant histology in this cohort.

Duration	Number Of Patients	Percentage
< 12 Months	13	16.46%
12–24 Months	22	27.89%
> 24 Months	44	55.75%

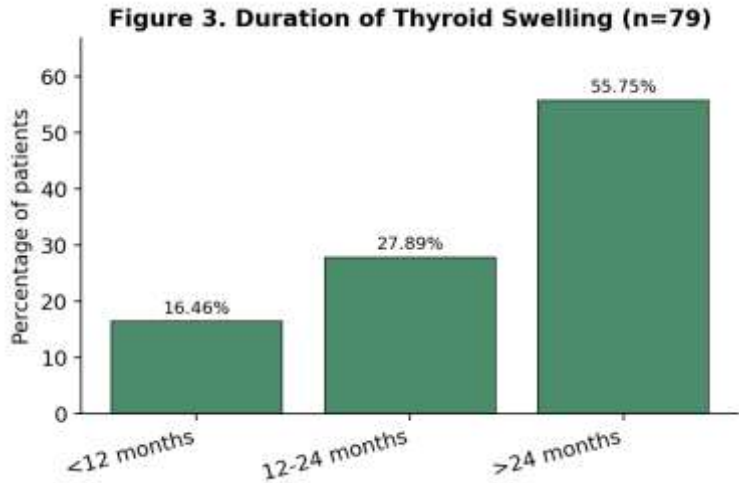


Figure 3. Duration of Thyroid Swelling At Presentation.

Associated Clinical Features and Thyroid Functional Status

Difficulty in swallowing was reported by 7 patients (9.09%), change of voice by 5 patients (6.49%), and a positive family history of thyroid disease was elicited in 10 patients (12.98%). On thyroid function testing, 54 patients (68.65%) were euthyroid, 14 (17.73%) were hyperthyroid and 11 (13.92%) were hypothyroid. Of the 79 nodules, 32 (40.51%)

were classified as a true solitary nodule of thyroid, while 47 (59.49%) proved on further evaluation to represent a dominant nodule within a multinodular goitre.

FNAC Diagnosis

Fine needle aspiration cytology classified the majority of nodules (82.28%) as benign. A suspicion of malignancy was raised in 10.13% of aspirates, and a further 7.69% were reported as suspicious for follicular neoplasm, a category

that inherently cannot be resolved without histopathological assessment of capsular and vascular invasion (Table 4, Figure 4).

FNAC Diagnosis	Number Of Patients	Percentage
Benign	65	82.28%
Suspicious Of Malignancy	8	10.13%
Suspicious Follicular Neoplasm	6	7.69%

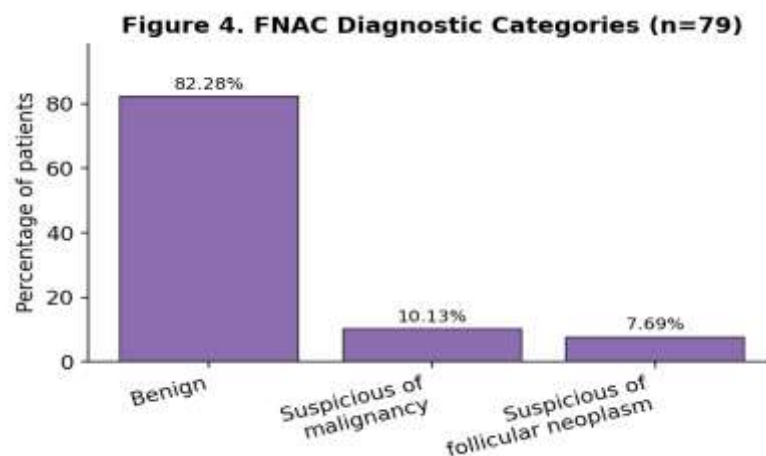


Figure 4. Distribution of FNAC Diagnostic Categories.

Histopathological Examination

On final histopathology, colloid goitre was the commonest diagnosis, accounting for 72.15% of specimens. Papillary carcinoma was found in 11.39%, lymphocytic (Hashimoto's) thyroiditis in 10.13%, and follicular carcinoma in 6.33%.

No case of anaplastic carcinoma was recorded in this series (Table 5, Figure 5). Combining papillary and follicular carcinoma, the overall incidence of malignancy in the study population was 17.72% (14 of 79 cases).

HPE Diagnosis	Number Of Patients	Percentage
Colloid Goitre	57	72.15%
Lymphocytic Thyroiditis	8	10.13%
Follicular Carcinoma	5	6.33%
Papillary Carcinoma	9	11.39%
Anaplastic Carcinoma	0	0%

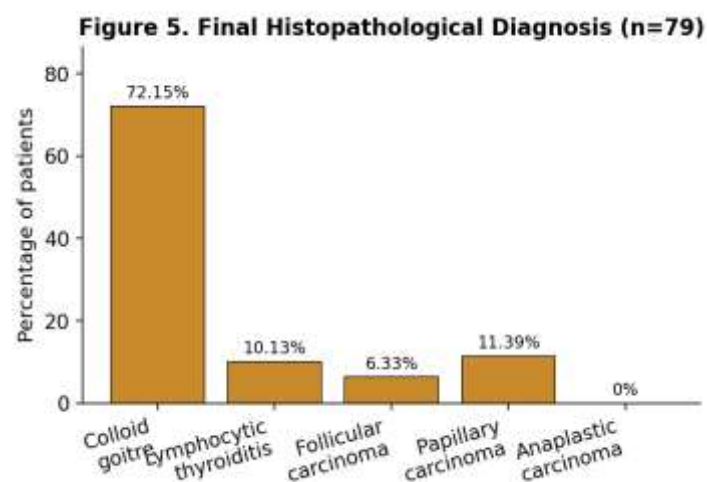


Figure 5. Distribution of Final Histopathological Diagnoses.

Malignancy Risk by Nodule Type and Surgical Management

When stratified by nodule type, malignancy was identified in 3 of 32 true solitary nodules (9.37%) compared with 9 of 47 multinodular goitre specimens harbouring a dominant nodule (approximately 20%), indicating that a multinodular gland did not confer protection against malignancy in this cohort. Total thyroidectomy was the most frequently performed procedure (58.3%), followed by hemi-thyroidectomy (41.56%), the choice being individualised according to nodule laterality, size and preoperative suspicion of malignancy.

Diagnostic Accuracy of FNAC and Postoperative Complications

Taking histopathology as the reference standard, FNAC in this study demonstrated a sensitivity of 91.8% and a specificity of 98.3%, with a positive predictive value of 81.4% and a negative predictive value of 90.7% (95% confidence interval, $p < 0.001$). Two patients with an initial false-negative FNAC subsequently required completion thyroidectomy after malignancy was identified on histopathology of the hemi-thyroidectomy specimen. Postoperative hypocalcaemia occurred in 11.68% of patients, recurrent laryngeal nerve injury in 9.09%, and postoperative hypothyroidism, expected after near-total or total thyroidectomy, in 46.75%. Wound-related sequelae included seroma in 9.09%, surgical site infection in 3.89%, and hypertrophic scarring or keloid formation in 6.49% of patients.

DISCUSSION

Most patients with thyroid disease clinically present with swelling in front of the neck and are usually euthyroid, although some may be associated with hypothyroidism or hyperthyroidism, consistent with the functional status distribution recorded in this cohort. Ultrasonography, and occasionally computed tomography, helped assess the location and morphology of the lesion in each case.

Duration of Complaints

This study evaluated 79 patients presenting with thyroid swelling to the Department of General Surgery of a tertiary care teaching hospital, taking a detailed clinical history and characterising each nodule by clinical examination, FNAC and ultrasonography before planning surgery and correlating the preoperative work-up with the final histopathological diagnosis.

Age Distribution

The age of the patients in this series ranged from 17 to 72 years, with the majority of patients above 40 years of age. This age distribution was comparable to that reported by Mandal S et al¹². In contrast, Sangalli et al¹³ found that the majority of cases occurred in the third and fourth decades, and Handa et al¹⁴ similarly reported a peak incidence in the 21–40 year age group, accounting for 64% of 226 cases, with the lowest proportion in the seventh decade. The present study's age profile is broadly comparable to these previously published series, with minor variation likely reflecting differences in referral pattern and the underlying age structure of the population served.

Sex Distribution

A pronounced female preponderance was observed in this study, with a female-to-male ratio of approximately 19:1, consistent with the well-established observation that thyroid disease is several times more common in women than men². Comparable female-to-male ratios have been reported in the series by Mandal S et al¹² (5:1), Handa et al¹⁴ (6.35:1) and Sangalli et al¹³ (4.21:1); the wider ratio observed here, while numerically greater, is directionally consistent with this existing literature (Table 6).

Sex Ratio (Female : Male)	Mandal S Et Al	Handa Et Al	Sangalli Et Al	Present Study
Ratio	5:1	6.35:1	4.21:1	18.75:1

Swelling in the region of the thyroid was the chief complaint in all 79 cases, with duration ranging from 4 months to 7 years. Consistent with prior reports, the duration of swelling did not show any significant association with malignant histology in the present study, reinforcing that symptom chronology is a poor discriminator of malignancy risk and that cytological and sonographic assessment should instead guide the decision to intervene⁸. Seven of the 79 patients reported difficulty in

swallowing, and five reported a change of voice, as part of their presenting complaints.

Role of Fine Needle Aspiration Cytology

FNAC of the thyroid is a well-established and cost-effective diagnostic test for the evaluation of thyroid disorders^{4,5}. It occupies a central role in the management of thyroid lesions, should be used as an initial diagnostic test, and contributes significantly to the preoperative assessment of patients with thyroid swelling. The sensitivity and specificity of thyroid FNAC have been reported to range from 57% to 99% and 90% to 99% respectively⁶. In the present study, 65 of the 79 cases (82.28%) were non-

neoplastic and the remaining 14 (17.72%) were neoplastic, giving a ratio of non-neoplastic to neoplastic disease of approximately 4.64:1. Non-neoplastic lesions predominated among females, consistent with the overall sex distribution of the cohort. Among the non-neoplastic lesions, the majority represented either a dominant nodule within a multinodular goitre or a true solitary nodule; among the neoplastic cases, papillary carcinoma was the commonest, accounting for 9 cases, followed by follicular carcinoma, accounting for 5 cases, a distribution comparable to that reported by Kessler et al¹¹ (Table 7).

Study	No. Of Cases	Non-Neoplastic	Neoplastic
Sangalli Et Al	5469	3343	2126
Kessler Et Al	170	100	70
Handa Et Al	66	54	12
Present Study	79	65	14

Surgical Procedure

The type of thyroidectomy was individualised based on the size and location of the thyroid swelling and its fixity to underlying structures. Total thyroidectomy (58.3%) was the most common procedure performed, followed by hemi-thyroidectomy (41.56%) when the lesion was confined to one lobe. Near-total and total thyroidectomy were preferred when the whole gland was involved, as is commonly seen in long-standing multinodular goitre or in confirmed malignancy.

Histopathology and Incidence of Malignancy

Histopathological evaluation in this study showed colloid goitre to be the commonest

diagnosis (72.15%), followed by papillary carcinoma (11.39%), lymphocytic thyroiditis (10.13%) and follicular carcinoma (6.33%); no case of Hürthle cell neoplasm, anaplastic carcinoma or lymphoma was recorded. The overall incidence of malignancy, 17.72%, was considerably higher than the 4.2% and 4% reported by Belfiore et al¹⁶ and by Munnir A et al¹⁷ respectively (Table 8), a difference that most plausibly reflects referral bias toward surgically managed, cytologically higher-risk nodules at a tertiary teaching centre rather than a true difference in population prevalence of thyroid malignancy.

Study	Incidence Of Malignancy
Belfiore Et Al	4.2%
Munnir A Et Al	4%
Present Study	17.72%

The incidence of malignancy in solitary nodules and in multinodular goitres was 9.37% and approximately 20% respectively in the present study (Table 9), indicating that a multinodular gland did not confer protection against malignancy in this cohort^{20,21}. This finding is of

direct clinical relevance in a setting where multinodular goitre is endemic, as reassurance based on nodularity alone may lead to under-investigation of a clinically significant malignancy²².

Type Of Goitre	Benign	Malignant
Solitary Nodule Thyroid	29	3
Multinodular Goitre	38	9

Correlation of FNAC with Histopathology

The specificity of the present study, 98.3%, is comparable to the specificity reported by Mandal S et al¹², while the sensitivity of 91.8% considerably exceeds the 63.3% sensitivity reported by Bamanikar et al¹⁵, although the latter study's low positive and negative predictive values likely reflect a small proportion of malignant cases in their sample rather than a true difference in test performance (Table 10). In two patients, FNAC was false-negative for malignancy, which was subsequently confirmed on histopathology after completion thyroidectomy, underscoring the recognised limitation of FNAC in distinguishing follicular adenoma from follicular carcinoma, a distinction that depends on histological assessment of capsular and vascular invasion and cannot be made on cytology alone.

Parameter	Mandal S Et Al	Bamanikar Et Al	Present Study
Sensitivity	90%	63.3%	91.8%
Specificity	84.6%	98.06%	98.3%
Positive Predictive Value	88.9%	0%	81.4%
Negative Predictive Value	86.5%	0%	90.7%

Complications

The surgical complications of thyroid surgery include recurrent laryngeal nerve palsy, hypocalcaemia due to inadvertent injury or devascularisation of the parathyroid glands, secondary haemorrhage, and recurrence of malignancy. In a study by Flynn et al²⁴, transient hypocalcaemia was reported in 42% of patients, while Pandey et al²⁵ reported hypocalcaemia in 3.75% of patients; in the present study, its prevalence was 11.68%. Recurrent laryngeal nerve palsy occurred in 9.09% of cases, secondary haemorrhage in 2%, and postoperative hypothyroidism, expected after near-total or total thyroidectomy, in 46.75% of cases. Permanent hypoparathyroidism occurred in a small proportion of patients, always in association with total thyroidectomy, similar to the experience of Pandey et al²⁵, and was managed successfully with supplemental calcium and vitamin D analogues.

Clinical Implications

Taken together, these findings support a diagnostic pathway in which every palpable thyroid nodule, whether apparently solitary or dominant within a multinodular gland, undergoes ultrasonography and FNAC before a decision on surgery is made, with a low threshold for surgical excision and histopathological confirmation whenever cytology is indeterminate, suspicious, or discordant with the clinical picture. This approach balances the need to avoid unnecessary surgery for the majority of benign nodules against the imperative not to miss the substantial minority, nearly one in six patients in this cohort, in whom malignancy is ultimately confirmed.

Limitations

This study was conducted at a single tertiary care centre with a comparatively modest sample size of 79 patients, which may limit the precision of subgroup estimates such as malignancy risk stratified by individual clinical risk factors, and referral bias toward surgically managed patients may have inflated the observed malignancy rate relative to the general population. Molecular and genetic markers of malignancy risk were not assessed in this study and represent an area for future prospective research.

CONCLUSION

This prospective observational study of 79 patients presenting with thyroid swelling to a tertiary care teaching hospital found that solitary and dominant thyroid nodules predominantly affected women, with a mean age of presentation of 42.6 years (range 17–72 years) and marked female preponderance (female-to-male ratio approximately 12:1). Swelling in front of the neck was the universal presenting complaint, and duration of swelling, ranging from 4 months to 7 years, showed no significant association with malignant histology. Total thyroidectomy (58.3%) was the most frequently performed procedure, followed by hemi-thyroidectomy (41.56%), the choice being individualised according to nodule size, laterality and preoperative suspicion of malignancy. The postoperative course was notable for recurrent laryngeal nerve palsy in 9.09% of cases, secondary haemorrhage in 2%, hypocalcaemia in 11.68%, and postoperative hypothyroidism, expected after near-total or total thyroidectomy, in 46.75% of cases; complication rates were broadly comparable to those reported in the existing literature.

On final histopathology, colloid goitre was the predominant diagnosis (72.15%), followed by papillary carcinoma (11.39%), lymphocytic thyroiditis (10.13%) and follicular carcinoma (6.33%), with no case of anaplastic carcinoma. The overall incidence of malignancy was 17.72%, and malignancy was identified in 9.37% of true solitary nodules compared with approximately 20% of dominant nodules within a multinodular goitre, confirming that a multinodular gland does not confer protection against malignancy. Two patients required completion thyroidectomy after an initially false-negative FNAC was subsequently confirmed as malignant on histopathology. Overall, FNAC performed well as a triage investigation in this cohort, with a sensitivity of 91.8% and specificity of 98.3% against histopathology, but its recognised limitation in distinguishing follicular adenoma from follicular carcinoma means that surgical excision with histopathological confirmation remains indispensable for definitive diagnosis. These findings reinforce the value of a structured clinical-cytological-histopathological pathway for every patient presenting with a thyroid nodule, and support individualising the extent of thyroidectomy according to cytological risk in order to balance oncological safety against surgical morbidity.

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