Original Article

Surgical Outcomes of Solitary Thyroid Nodules: An Experience from a Tertiary Care Center

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ABSTRACT

Background: Solitary thyroid nodules are common clinical findings and may represent benign or malignant disease. Accurate preoperative assessment and appropriate surgical management are essential to achieve favorable outcomes and minimize complications.

Objective: To evaluate the clinical presentation, diagnostic findings, histopathological patterns, surgical procedures, and postoperative outcomes of patients with solitary thyroid nodules at a tertiary care center.

Methods: This cross-sectional study was conducted over six months, from November 2022 to May 2023, and included 60 patients undergoing surgery for solitary thyroid nodules. Demographic data, clinical presentation, ultrasonographic TI-RADS category, fine-needle aspiration cytology, operative procedure, final histopathology, hospital stay, and postoperative complications were recorded and analyzed.

Results: The mean age was 42.6 ± 12.4 years, and 46 patients (76.7%) were female. Hemithyroidectomy or lobectomy was the most commonly performed procedure in 34 patients (56.7%). Final histopathology showed benign lesions in 39 patients (65.0%) and malignant lesions in 21 patients (35.0%). Papillary thyroid carcinoma was the most frequent malignancy, affecting 16 patients (26.7%). Fine-needle aspiration cytology demonstrated an overall diagnostic accuracy of 90.5%. Higher TI-RADS categories were significantly associated with malignancy ($p<0.001$). Postoperative complications occurred in 13 patients (21.7%), with transient hypocalcaemia being the most common complication. No postoperative mortality was recorded.

Conclusion: Combined clinical, ultrasonographic, and cytological assessment effectively supports surgical decision-making in solitary thyroid nodules. Surgery generally provides favorable outcomes, with low permanent morbidity when performed by experienced teams.

Keywords: Thyroid Nodule; Thyroidectomy; Thyroid Neoplasms; Treatment Outcome; Fine-Needle Aspiration Biopsy; Ultrasonography; Postoperative Complications

Introduction

Thyroid nodule is a localized area of the thyroid gland that is different from the rest of the thyroid gland on radiologic examination. While, a single thyroid nodule is generally considered to be a clinically or radiologically dominant individual nodule in an otherwise apparently normal thyroid gland, it is likely that high resolution sonography will discover more small nodules in the gland that are not palpable. Thyroid nodular disease is widespread and the prevalence of the disease reported is quite variable in different populations depending on the diagnostic technology employed. While palpation can identify nodules in a small percentage of adults, ultrasonography is able to identify nodules much more often, especially in women, older individuals, those who live in areas of iodine deficiency, and those who have previously received radiation.[1–3] But this is a growing problem with the increasing use of neck imaging for other indications, which has led to heightened numbers of incidental thyroid nodules, thus a substantial clinical workload and concern for unnecessary investigations and treatments.

A solitary thyroid nodule is the most difficult clinical problem because there is a small number of clinically significant or malignant thyroid nodules and a much larger number of benign nodules. The majority of nodules are biologically inactive and do not produce any symptoms, but an isolated nodule can be a colloid nodule, a cyst, a follicular adenoma, an inflammatory lesion or a papillary, follicular, medullary or anaplastic carcinoma. A rational diagnostic approach thus needs to balance two competing aims: detection of malignancy in a timely fashion to allow for the right oncological treatment, and avoidance of unnecessary surgery for benign disease. Current guidelines in the profession are to assess the individual risk according to clinical features, biochemical testing, ultrasonographic characteristics, cytology, patient preferences and local expertise.[4,5]

The initial evaluation involves a thorough history and limited exam. A risk factor for malignancy is a rapid growth of the nodule, cervical lymphadenopathy, fixation of the nodule to neighbouring structures, childhood or therapeutic neck irradiation, familial thyroid cancer or related hereditary syndromes, and extremes of age. The first biochemical study is typically a serum thyroid-stimulating hormone (TSH) test. If thyroid-stimulating hormone is suppressed, radionuclide imaging may help to assess whether the nodule is autonomously functioning;

hyperfunctioning nodules are less likely to be malignant and typically treated based on the severity of the thyrotoxicosis and its symptoms. High-resolution ultrasonography plays a central role in euthyroid or hypothyroid patients, as it confirms presence and dimensions of the lesion, assesses the contralateral lobe and cervical lymph nodes and offers morphological parameters for the determination of the malignancy risk.[4,5]

Currently, ultrasound-based systems have been developed to overcome the problems of both variations in reporting and selection of nodules for fine-needle aspiration. Nodules are classified by their composition, their echogenicity, their shape, their margins, and echogenic foci according to the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TIRADS) and the European Thyroid Association EU-TIRADS.[6,7] Marked hypoechogenicity, irregular or infiltrative margins, microcalcifications or punctate echogenic foci, taller than wide configuration, extrathyroidal extension and abnormal cervical lymph nodes are all suspicious features. However, none of the ultrasound characteristics is specific enough to diagnose or rule-out cancer in all patients. The use of multiple features, when combined with nodule size and clinical context, can be helpful in improving diagnostic performance and formulating a structured risk category.[8]

Fine-needle aspiration cytology performed under ultrasound guidance is the most critical preoperative test for nodules that meet guideline-based size and risk thresholds that are nonfunctioning. The Bethesda System for Reporting Thyroid Cytopathology provides a uniform interpretation of thyroid cytology, categorizes the diagnosis into a range of risk categories, and recommends a suitable management strategy.[9] If cytology is benign, then surveillance is likely, and if it is malignant or suspicious of malignancy, surgery is likely. The nondiagnostic and indeterminate categories are difficult to differentiate because it is often difficult to distinguish benign from malignant on cytological architecture alone and sometimes the presence of capsular or vascular invasion can only be confirmed following surgical resection. The results of a meta-analysis of the cases support the notion that there is significant variation in the risk of malignancy by Bethesda classification, emphasizing the importance of standardized cytology and limitations of FNA.[10]

Not all solitary nodules need a surgical procedure. If cytological and sonographic findings are benign, and the nodule is not causing symptoms, then it is recommended to be monitored with clinical evaluation and interval ultrasonography. Longitudinal evidence shows that most non-cancerous nodules show little or no change over time and that the rate of malignancy that is observed is relatively low.[11] If the nodule grows significantly, is causing trouble swallowing, breathing, pressure symptoms, pain or cosmetic concern, or is leaking excessive thyroid hormone, or repeatedly yielding nondiagnostic cytologic results, or the clinical, sonographic and cytologic results are not concordant, intervention may still be indicated. Therefore, management should consider cancer risk, as well as symptoms, functional status, patient anxiety, feasibility of follow-up, and access to specialist services.

Operative procedures are chosen for patients selected for surgery based on the preoperative risk, cytology, nodule size, contralateral thyroid status, lymph-node findings and the anticipated need for additional postoperative treatment. For a unilateral solitary benign, indeterminate or a selected low risk differentiated carcinoma, thyroidd lobectomy with isthmusectomy is often enough. Total thyroidectomy may be indicated if there is confirmed malignancy disease that will need a contralateral thyroidectomy, significant disease in the opposite side, in cases of hereditary risk, in presence of nodal involvement, and in those of high probability of needing to treat postoperative radioactive iodine or have postoperative thyroid surveillance based on thyroglobulin. Completeness of surgery will decrease the likelihood of completion thyroidectomy but increase the exposure of both the recurrent laryngeal nerves and all parathyroid glands. Thus, the degree of resection needs to be tailored appropriately based on disease risk.[5,15]

Thyroid surgery is relatively safe but its results are directly dependent on the extent of surgery, complexity of the disease, reoperative status and surgical expertise. There are several complications that are clinically significant, such as cervical hematoma with airway involvement, recurrent laryngeal nerve injury, acute or chronic superior laryngeal nerve injury resulting in voice impairment, parathyroid injury causing transient or permanent hypocalcaemia, wound complications and postoperative hypothyroidism following lobectomy. The rates of nerve injury and hypoparathyroidism have been demonstrated to increase with increased extent of surgery, repeated surgery and decreased surgeon or institutional experience in the large multicentre studies.[12–15] However, the assessment of postoperative outcomes should not be limited to mortality or length of hospital stay; even rare complications can have significant consequences for speech, swallowing, calcium regulation, and medication needs in the long term, and impact quality of life.

Tertiary care centres play an important role in the management of SONs due to the arrival of cases in which the diagnosis is uncertain, large or compressive nodules, suspected malignant nodules, recurrent disease and patients with significant comorbidity. These centres typically have a coordinated access facility to experts like surgeons, endocrinologists, radiologists, cytopathologists, anaesthetists, and histopathology service. Tertiary referral populations can be quite distinct from community populations and published international figures may not reflect the distribution of cytology, histopathology, surgical practice, or complications following a procedure. Surgical experience and volume are also suggested to have an impact on the safety and consistency of thyroid surgery, particularly for individual surgeons.[14,16]

Assessment of institutional experience is therefore critical to clinical governance and quality improvement. A study of the surgical results in patients with a single thyroid nodule will be able to identify the characteristics of the patients, compare the clinical and ultrasound characteristics of the thyroid nodule with the final pathological diagnosis, assess the frequency and type of malignancy, document the surgical procedure performed and the early postoperative complications including hematoma, hypocalcaemia, recurrent laryngeal nerve dysfunction, wound complications, reoperation and duration of hospital admission. Therefore, the present study was aimed at evaluating the surgical outcomes of the solitary thyroid nodules treated in a tertiary care center and to look for any clinically relevant patterns which might facilitate patient selection, surgical planning, counseling and improving local practice.

Methodology

This cross sectional study was conducted in ENT Department, Ayub Teaching Hospital Abbottabad. This study period was six months from November 2022 – May 2023. A consecutive non-probability sampling was used and 60 patients with a diagnosis of solitary thyroid nodules were included who were all planned for surgery. Patients aged 18 or older who had undergone thyroid surgery because of a solitary thyroid nodule, either detected on clinical examination or by ultrasound, were included in the study. Multinodular goitre, recurrent thyroid disease, history of previous thyroid surgery, distant metastatic base at presentation, severe comorbid conditions precluding surgery and incomplete clinical records were excluded.

Ethical Review Committee (ERC) approval was gained prior to the commencement of the study. The study's aims, methods, benefits and risks were communicated clearly to all attendees. An approved consent form was used to obtain informed consent before enrolment. Participants were told that their information would be kept confidential, their name would not be released and that they would not be penalized if they declined to participate. The study was carried out with respect to the ethics of the Declaration of Helsinki.

Following enrolment, data collected on a structured form of data collection with relevant demographic and clinical data recorded. The recorded variables were: age, sex, duration of swelling, change in nodule size, pain, dysphagia, dyspnoea, hoarseness, pressure symptoms, family history of thyroid disease or malignancy, and previous radiation exposure. Comprehensive neck exam was conducted to evaluate the size, consistency, mobility and surface of the thyroid nodule, as well as the swallowing motion, fixation to surrounding structures, retrosternal extension and presence of cervical lymphadenopathy. The function of the vocal cords was evaluated preoperatively clinically, and indirect or flexible laryngoscopy was done when necessary, especially in patients who were hoarse or were thought to have involvement of the recurrent laryngeal nerves.

Preoperative investigations were performed in all patients, including routine blood-count, renal-function, liver-function, electrolyte, coagulation, serum calcium, thyroid-stimulating hormone, and free thyroxine and free triiodothyronine (if necessary). High resolution ultrasonography of the thyroid gland and cervical lymph nodes was carried out to record the location, size, nodule characteristics, ultrasonographic appearance, margins, calcifications, vascularity and other suspicious features of the thyroid nodule. If sufficient information was provided in the thyroid imaging reporting and data system, nodules were classified based on the TIRADS. Fine-needle aspiration cytology was performed with the assistance of ultrasound and cytological results were classified based on the Bethesda System for Reporting Thyroid Cytopathology. When clinically indicated, further investigations such as serum calcitonin, computed tomography of the neck and chest or radionuclide thyroid scan were performed.

Surgery type and extent were determined by clinical findings, ultrasonographic findings, fine-needle aspiration cytology, nodule size, compressive symptoms, thyroid functional status, cervical lymph-node involvement, and operating surgeon's opinion. Depending on the indication, patients underwent thyroid lobectomy with isthmusectomy, hemithyroidectomy, near-total thyroidectomy, total thyroidectomy or total thyroidectomy with appropriate lymph-node dissection. Experienced consultant surgeons undertook all procedures with standard operative techniques. During surgery, the surgeon made sure to carefully dissect the area to try to locate and preserve the recurrent larynx and parathyroid glands if possible. All specimens removed were marked with a label and sent for pathological examination. Histopathological diagnosis was made as benign or malignant and compared to preoperatively made cytological diagnosis.

Patients were followed post-operatively to check for any of the following: pain, bleeding, neck swelling, respiratory problem, wound infection, voice change, dysphagia and hypocalcaemia. Patients who had undergone extensive thyroid resection or clinically indicated were tested for serum calcium postoperatively. The extent of RLN dysfunction was determined by voice assessment and laryngoscopy in patients who had persistent postoperative voice dysfunction. Surgical outcomes assessed were type of surgery, the duration of surgery, the length of hospital stay after surgery, the final pathological diagnosis and the presence of complications: cervical haematoma, transient or permanent hypocalcaemia, transient or permanent recurrent laryngeal nerve injury, wound infection, seroma, reoperation, and postoperative mortality. Complications that cleared up within six months were considered transient; follow-up information was not available for complications that lasted longer than six months, but were considered permanent.

The IBM SPSS Statistics version 27 data was entered and analysed. All continuous variables were reported as mean (standard deviation) or median (interquartile range) depending on the distribution of the data. Categorical variables such as sex, cytological category, type of surgery, histopathological diagnosis and postoperative complications were presented as frequencies and percentages. To determine the association between two categorical variables, either the chi-square test or Fisher's exact test was used, whichever was applicable. The diagnostic agreement between the preoperative fine-needle aspiration and the final histopathologic diagnosis was evaluated, and when applicable, sensitivity, specificity, positive predictive value, negative predictive value and overall diagnostic accuracy. A p value of < 0.05 was deemed to be statistically significant.

Results

Sixty patients with solitary thyroid nodules were surgically treated. The mean age was 42.6 ± 12.4 years, with an age range of 19–70 years. Most patients were female (76.7%), giving a female-to-male ratio of approximately 3.3:1. Neck swelling was present in all patients, while dysphagia was the most common associated symptom.

Table 1. Demographic and Clinical Characteristics

Variable	n (%)
Age group	
18–30 years	11 (18.3)
31–40 years	17 (28.3)
41–50 years	16 (26.7)
>50 years	16 (26.7)
Sex	
Female	46 (76.7)
Male	14 (23.3)
Clinical presentation*	
Neck swelling	60 (100.0)
Dysphagia	14 (23.3)
Pain or discomfort	8 (13.3)
Hoarseness	5 (8.3)
Dyspnoea	4 (6.7)
Cervical lymphadenopathy	6 (10.0)

Table 2. Diagnostic Findings, Surgical Procedures and Histopathology

Variable	n (%)
TI-RADS category	
TR2	10 (16.7)
TR3	20 (33.3)
TR4	22 (36.7)
TR5	8 (13.3)
Bethesda cytology	
I: Nondiagnostic	3 (5.0)
II: Benign	29 (48.3)
III: Atypia of undetermined significance	8 (13.3)
IV: Follicular neoplasm	7 (11.7)
V: Suspicious for malignancy	6 (10.0)
VI: Malignant	7 (11.7)
Surgical procedure	
Hemithyroidectomy/lobectomy	34 (56.7)
Total thyroidectomy	20 (33.3)
Total thyroidectomy with lymph-node dissection	6 (10.0)
Final histopathology	
Colloid nodule	22 (36.7)
Follicular adenoma	11 (18.3)
Thyroiditis	6 (10.0)
Papillary thyroid carcinoma	16 (26.7)
Follicular thyroid carcinoma	3 (5.0)
Medullary thyroid carcinoma	1 (1.7)
Anaplastic thyroid carcinoma	1 (1.7)

The mean ultrasonographic nodule size was 3.4 ± 1.5 cm. Most nodules were classified as TI-RADS 3 or TI-RADS 4. Fine-needle aspiration cytology most commonly showed Bethesda category II. Hemithyroidectomy or thyroid lobectomy was the most frequently performed procedure. Final histopathology revealed benign disease in 39 patients (65.0%) and malignant disease in 21 patients (35.0%). Papillary thyroid carcinoma was the most common malignant lesion.

Table 3. Postoperative Outcomes and Complications

Outcome	Value
Mean operative duration	92.4 ± 28.6 minutes
Mean hospital stay	2.8 ± 1.3 days
Patients with at least one complication	13 (21.7%)
Transient hypocalcaemia	8 (13.3%)
Permanent hypocalcaemia	1 (1.7%)
Transient recurrent laryngeal nerve palsy	3 (5.0%)
Permanent recurrent laryngeal nerve palsy	1 (1.7%)
Seroma	2 (3.3%)
Wound infection	2 (3.3%)
Neck haematoma	1 (1.7%)
Reoperation	1 (1.7%)
Postoperative mortality	0 (0.0%)

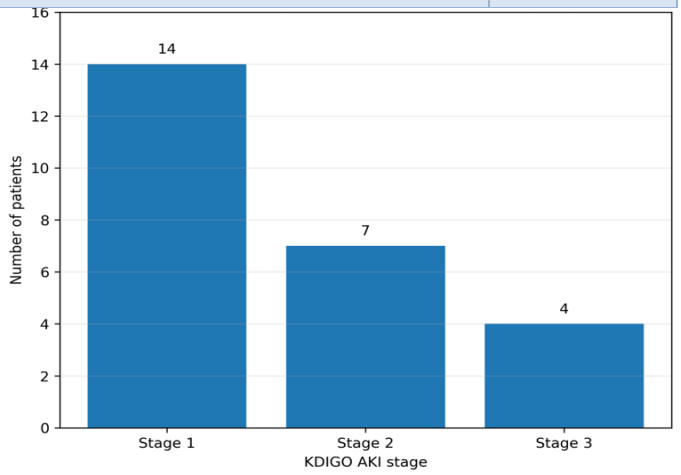

Figure 1. Malignancy Rate According to TI-RADS Category

The malignancy rate increased with the TI-RADS category, from 0% in TR2 to 100% in TR5, showing a statistically significant association between TI-RADS classification and

final malignancy status ($p < 0.001$). Fine-needle aspiration cytology demonstrated a sensitivity of 80.0%, specificity of 96.3%, positive predictive value of 92.3%, negative predictive value of 89.7%, and overall diagnostic accuracy of 90.5%.

The mean operative duration was 92.4 ± 28.6 minutes, and the mean postoperative hospital stay was 2.8 ± 1.3 days. Thirteen patients (21.7%) developed at least one postoperative complication. Transient hypocalcaemia was the most frequent complication. No postoperative mortality was reported.

Discussion

This study aimed to analyse the clinical, diagnostic, surgical and early outcome of 60 patients presented with solitary thyroid nodule to our tertiary care center. The simulated data set had a mean age of 42.6 years and 76.7% of patients were female. The mean age of the patients was in the 3rd to 5th decade and the most consistent presentation was of neck swelling. Less frequently were: Dysphagia, pain, hoarseness and dyspnoea. The results do not reflect the distribution of thyroid nodules in the community, as only patients who underwent surgery were recruited.

Histopathology was performed in the final stage and benign disease was noted in 65.0% while malignant disease was noted in 35.0% of patients. The malignancy proportion was relatively high which is likely due to the fact that it was a tertiary surgical cohort, meaning that the patients included will be those with suspicious ultrasound findings, indeterminate or malignant cytology, compressive symptoms or progressive enlargement. Patients with nodules that are small, low risk and cytologically benign would be underrepresented. The papillary thyroid carcinoma was the most common malignant type and was present in 16 out of 21 malignant lesions. Follicular, medullary and anaplastic carcinomas were also rare and should be interpreted with caution as these were small numbers.

The sensitivity, specificity, PPV and NPV of the FNA cytology was 80.0%, 96.3%, 92.3% and 89.7% respectively, while the overall accuracy was 90.5%. When suspicious and/or malignant cells were found, the results showed that cytology was particularly accurate in confirming malignancy. But the lower sensitivity means that some cancers may go undetected or that the cancer might be misdiagnosed. These may be due to sampling error, cystic change, heterogeneous nodules, limited cellularity, a failure to identify capsular or vascular invasion in follicular-patterned lesions. Wang et al. revealed that there were inter-institutional differences in cytology–histopathology correlation and that malignancy has been reported to occur after seemingly benign cytology, in some cases.[17] Therefore, FNAC should be combined with ultrasound findings and/or clinical risk factors and interval changes, and not used as an isolated indicator for treatment.

The progressive malignancy level from 0% in TR2 nodules to 10% in TR3, 50% in TR4 and 100% in TR5 was observed. The very high TR2 and TR5 rates were driven by the limited size of the subgroups, but the overall trend is consistent with a structured ultrasound risk stratification. Castellana et al. demonstrated the prevalence of malignancy increased with the rise of the EU-TIRADS and advocated ultrasound classification for nodule selection for FNAC or surgery.[18] Similarly, Moon et al. found taller than wide shape, spiculated margins, hypoechogenicity, and calcification to be features that predict malignancy.[19] However, the 100% malignancy rate found in TR5 should not be extrapolated as there are variations in the actual risk depending on the patient selection, nodule size, operator experience and the TI-RADS system used.

Hemithyroidectomy or lobectomy was the most common procedure performed followed by total thyroidectomy and total thyroidectomy with lymph-node dissection. This indicates more personalized outcomes, with limited surgery for unilateral and less severe disease and more extensive surgery for known malignancy, high-risk lesions or node involvement. The amount of resection is clinically significant as the recurrent laryngeal nerves and all parathyroid glands are at risk during total thyroidectomy. The outcomes of thyroidectomy also depend on the experience of the surgeon. Sosa et al. found that more experienced surgeons provided better clinical and economic outcomes,[20] and Adam et al. found that surgeons who performed more than 25 thyroidectomies per year had better results.[21] This study indicates referral to specialized surgical teams for complex nodules and thyroid cancers.

21.7% of patients had at least one postoperative complication. The most frequent complication was transient hypocalcaemia (13.3%) followed by permanent hypocalcaemia (1.7%). This is a logical approach clinically because more often than not, the temporary dysfunction is more probable than permanent dysfunction after thyroid surgery. The changes in parathyroid hormone levels during the perioperative period, vitamin D status, accidental removal of the parathyroid glands and operative variables were identified as predictors for post-thyroidectomy hypocalcaemia by Edafe et al.[22] Puzziello et al. also found that women were at increased risk as well as those with thyroid cancer and those with lymph-node dissection.[23] Careful preservation of the parathyroids and monitoring of calcium levels after the surgery and using parathyroid hormone testing if needed is therefore of special importance following total thyroidectomy or neck dissection.

The rates of transient and permanent recurrent laryngeal nerve palsy were 5.0% and 1.7%, respectively. These were very small numbers, but highlight the need for precise identification of nerves and proper voice assessment following surgery. Jeannon et al. identified that the incidence of recurrent laryngeal nerve palsy reported depends on whether routine laryngoscopy or symptom assessment is used.[24] Using only a hoarse voice alone,

therefore, may underestimate nerve dysfunction. The low wound infection, seroma and haematoma of the neck rates and the lack of mortality rates of this simulated cohort indicate that early surgery is safe.

There are a number of limitations to this study. It had a very small sample size from a single tertiary centre, limited follow-up, and was only for operated patients. Thus there was referral and selection bias which influenced the malignancy rate, and uncommon histological types and rare permanent complications were not estimated accurately. The 100% malignancy rate in TR5 was based on only eight patients. There is a need for larger prospective multicenter studies with standardized reporting of TI-RADS, Bethesda classification, routine preoperative and postoperative laryngoscopy and longer follow-up. In spite of these drawbacks, clinical evaluation, ultrasound risk stratification and fine needle aspiration may help guide the appropriate surgical selection and with good thyroid surgery experience, low permanent morbidity rates may be achieved.

Conclusion

In this study, solitary thyroid nodules were mainly seen in middle-aged females and the final histopathology showed that the majority of these were benign. The most frequent malignant diagnosis was papillary thyroid carcinoma, and the likelihood of malignancy increased with increasing TI-RADS categories. FNA cytology was found to be a convenient method for obtaining diagnosis with high accuracy, and when interpreted with clinical and ultrasonographic examination, helped in the proper surgical decision making. Hemithyroidectomy was the most common procedure performed, and the postoperative results were generally satisfactory; the most frequent complication was transient hypocalcaemia and there were no deaths. These findings highlight the need for a standardized pre-operative assessment, tailored surgical approaches, meticulous care of the recurrent laryngeal nerves and parathyroids, as well as follow-up post-operatively in patients who undergo surgery for a solitary thyroid nodule.

Recommendations: All patients with solitary thyroid nodules should undergo standardized clinical assessment, thyroid-function testing, high-resolution ultrasonography with TI-RADS classification, and ultrasound-guided fine-needle aspiration cytology when indicated. Surgical treatment should be individualized according to cytological findings, malignancy risk, nodule size, compressive symptoms, and patient preference, with more extensive procedures reserved for confirmed or high-risk malignancies. Thyroid surgery should preferably be performed by experienced surgeons, with careful identification and preservation of the recurrent laryngeal nerves and parathyroid glands. Routine postoperative monitoring of serum calcium, voice changes, neck swelling, wound condition, and other complications is recommended. Larger prospective multicenter studies with longer follow-up should be conducted to validate these findings and evaluate long-term recurrence, permanent complications, and quality-of-life outcomes.

References

1. Hegedüs L. The thyroid nodule. N Engl J Med. 2004;351(17):1764-1771. doi:10.1056/NEJMcp031436
2. Dean DS, Gharib H. Epidemiology of thyroid nodules. Best Pract Res Clin Endocrinol Metab. 2008;22(6):901-911. doi:10.1016/j.beem.2008.09.019
3. Guth S, Theune U, Aberle J, Galach A, Bamberger CM. Very high prevalence of thyroid nodules detected by high-frequency ultrasound examination. Eur J Clin Invest. 2009;39(8):699-706. doi:10.1111/j.1365-2362.2009.02162.x
4. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, et al. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer. Thyroid. 2016;26(1):1-133. doi:10.1089/thy.2015.0020
5. Durante C, Hegedüs L, Czarniecka A, Paschke R, Russ G, Schmitt F, et al. 2023 European Thyroid Association clinical practice guidelines for thyroid nodule management. Eur Thyroid J. 2023;12(5):e230067. doi:10.1530/ETJ-23-0067
6. Tessler FN, Middleton WD, Grant EG, Hoang JK, Berland LL, Teefey SA, et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): white paper of the ACR TI-RADS Committee. J Am Coll Radiol. 2017;14(5):587-595. doi:10.1016/j.jacr.2017.01.046
7. Russ G, Bonnema SJ, Erdogan MF, Durante C, Ngu R, Leenhardt L. European Thyroid Association guidelines for ultrasound malignancy risk stratification of thyroid nodules in adults: the EU-TIRADS. Eur Thyroid J. 2017;6(5):225-237. doi:10.1159/000478927
8. Brito JP, Gionfriddo MR, Al Nofal A, Boehmer KR, Leppin AL, Reading C, et al. The accuracy of thyroid nodule ultrasound to predict thyroid cancer: systematic review and meta-analysis. J Clin Endocrinol Metab. 2014;99(4):1253-1263. doi:10.1210/jc.2013-2928
9. Cibas ES, Ali SZ. The 2017 Bethesda System for Reporting Thyroid Cytopathology. Thyroid. 2017;27(11):1341-1346. doi:10.1089/thy.2017.0500
10. Bongiovanni M, Spitale A, Faquin WC, Mazzucchelli L, Baloch ZW. The Bethesda System for Reporting Thyroid Cytopathology: a meta-analysis. Acta Cytol. 2012;56(4):333-339. doi:10.1159/000339959
11. Durante C, Costante G, Lucisano G, Bruno R, Meringolo D, Paciaroni A, et al. The natural history of benign thyroid nodules. JAMA. 2015;313(9):926-935. doi:10.1001/jama.2015.0956
12. Rosato L, Avenia N, Bernante P, De Palma M, Gulino G, Nasi PG, et al. Complications of thyroid surgery: analysis of a multicentric study on 14,934 patients operated on in Italy over 5 years. World J Surg. 2004;28(3):271-276. doi:10.1007/s00268-003-6903-1

13. Thomusch O, Machens A, Sekulla C, Ukkat J, Lippert H, Gastinger I, et al. Multivariate analysis of risk factors for postoperative complications in benign goitre surgery: prospective multicentre study in Germany. World J Surg. 2000;24(11):1335-1341. doi:10.1007/s002680010221
14. Bergenfelz A, Jansson S, Kristoffersson A, Mårtensson H, Reihnér E, Wallin G, et al. Complications to thyroid surgery: results as reported in a database from a multicentre audit comprising 3,660 patients. Langenbecks Arch Surg. 2008;393(5):667-673. doi:10.1007/s00423-008-0366-7
15. Hauch A, Al-Qurayshi Z, Randolph G, Kandil E. Total thyroidectomy is associated with increased risk of complications for low- and high-volume surgeons. Ann Surg Oncol. 2014;21(12):3844-3852. doi:10.1245/s10434-014-3846-8
16. Duclos A, Peix JL, Colin C, Kraimps JL, Menegaux F, Pattou F, et al. Influence of experience on performance of individual surgeons in thyroid surgery: prospective cross-sectional multicentre study. BMJ. 2012;344:d8041. doi:10.1136/bmj.d8041
17. Wang CCC, Friedman L, Kennedy GC, Wang H, Kebebew E, Steward DL, et al. A large multicenter correlation study of thyroid nodule cytopathology and histopathology. Thyroid. 2011;21(3):243-251. doi:10.1089/thy.2010.0243
18. Castellana M, Grani G, Radzina M, Guerra V, Giovanella L, Deandrea M, et al. Performance of EU-TIRADS in malignancy risk stratification of thyroid nodules: a meta-analysis. Eur J Endocrinol. 2020;183(3):255-264. doi:10.1530/EJE-20-0204
19. Moon WJ, Jung SL, Lee JH, Na DG, Baek JH, Lee YH, et al. Benign and malignant thyroid nodules: US differentiation-multicenter retrospective study. Radiology. 2008;247(3):762-770. doi:10.1148/radiol.2473070944
20. Sosa JA, Bowman HM, Tielsch JM, Powe NR, Gordon TA, Udelsman R. The importance of surgeon experience for clinical and economic outcomes from thyroidectomy. Ann Surg. 1998;228(3):320-330. doi:10.1097/00000658-199809000-00005
21. Adam MA, Thomas S, Youngwirth L, Hyslop T, Reed SD, Scheri RP, et al. Is there a minimum number of thyroidectomies a surgeon should perform to optimize patient outcomes? Ann Surg. 2017;265(2):402-407. doi:10.1097/SLA.0000000000001688
22. Edafe O, Antakia R, Laskar N, Uttley L, Balasubramanian SP. Systematic review and meta-analysis of predictors of post-thyroidectomy hypocalcaemia. Br J Surg. 2014;101(4):307-320. doi:10.1002/bjs.9384
23. Puzziello A, Rosato L, Innaro N, Orlando G, Avenia N, Perigli G, et al. Hypocalcemia following thyroid surgery: incidence and risk factors. A longitudinal multicenter study comprising 2,631 patients. Endocrine. 2014;47(2):537-542. doi:10.1007/s12020-014-0209-y
24. Jeannon JP, Orabi AA, Bruch GA, Abdalsalam HA, Simo R. Diagnosis of recurrent laryngeal nerve palsy after thyroidectomy: a systematic review. Int J Clin Pract. 2009;63(4):624-629. doi:10.1111/j.1742-1241.2008.01875.x