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Risk-Benefit Assessment of Total Thyroidectomy versus Hemithyroidectomy in the Management of Benign Thyroid Nodules

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ABSTRACT

Background: The optimal surgical approach for benign thyroid nodules remains controversial. This study aimed to compare the outcomes of total thyroidectomy versus hemithyroidectomy for benign thyroid nodules to inform clinical decision-making.
Methods: A prospective observational study was conducted on 70 patients (32 total thyroidectomy, 38 hemithyroidectomy) with benign thyroid nodules who underwent surgery between January and December 2024. Outcomes assessed included perioperative parameters, complications, functional outcomes, quality of life, and recurrence rates.
Results: The total thyroidectomy group had significantly larger nodules (3.8±1.2 vs. 3.2±0.9 cm, p=0.022) and higher prevalence of multinodular goiter (75.0% vs. 44.7%, p=0.011). Total thyroidectomy was associated with longer operative time (128.4±31.2 vs. 89.6±24.5 minutes, p<0.001), greater blood loss (78.5±36.2 vs. 52.3±28.7 mL, p=0.001), and extended hospital stay (3.2±0.9 vs. 2.1±0.8 days, p<0.001). Complication rates were significantly higher in the total thyroidectomy group (43.8% vs. 15.8%, p=0.009), primarily due to transient hypoparathyroidism (28.1% vs. 0%, p<0.001). All total thyroidectomy patients required levothyroxine compared to 18.4% in the hemithyroidectomy group (p<0.001). Quality of life assessment showed better overall scores in the hemithyroidectomy group (20.5±14.2 vs. 28.4±16.8, p=0.033). Among hemithyroidectomy patients, 18.4% developed new nodules and 5.3% required completion thyroidectomy within 12 months.
Conclusion: Hemithyroidectomy is associated with lower complication rates, reduced need for hormone replacement, and better quality of life compared to total thyroidectomy for benign thyroid nodules. However, these advantages must be balanced against the risk of recurrence and need for reoperation. The choice between procedures should be individualized based on patient characteristics, preferences, and risk profile.

Keywords: Thyroid nodules; Hemithyroidectomy; Total thyroidectomy; Complications; Recurrence; Quality of life; Hypoparathyroidism

INTRODUCTION

Thyroid nodules represent one of the most common endocrine disorders, with a prevalence of 4-7% when detected by palpation alone and 19-67% when identified using high-resolution ultrasonography.[1] While the vast majority of thyroid nodules are benign, they often necessitate surgical intervention due to compressive symptoms, cosmetic concerns, or diagnostic uncertainty despite fine-needle aspiration cytology (FNAC).[2] The optimal surgical approach for benign thyroid nodules remains a subject of ongoing debate within the endocrine surgery community, with the primary options being hemithyroidectomy (removal of the affected lobe and isthmus) and total thyroidectomy (complete removal of the thyroid gland).

The decision-making process regarding the extent of thyroid resection involves careful consideration of multiple factors, including the risk of recurrence, potential complications, need for lifelong hormone replacement therapy, and quality of life outcomes. Historically, hemithyroidectomy has been the preferred approach for benign, unilateral thyroid nodules due to its lower complication rates and the possibility of avoiding thyroid hormone supplementation.[3] The rationale supporting hemithyroidectomy includes preservation of thyroid function in 80-90% of patients, reduced risk of recurrent laryngeal nerve injury (particularly bilateral injury), and minimal risk of permanent hypoparathyroidism.[4] These advantages must be weighed against the approximately 10-20% risk of nodule recurrence in the contralateral lobe, which may necessitate completion thyroidectomy in the future.

Conversely, total thyroidectomy offers several potential benefits, including elimination of the risk of recurrence in the contralateral lobe, simplified follow-up protocols, and definitive treatment for conditions such as multinodular goiter that often affect both lobes.[5] Additionally, in cases where postoperative histopathology reveals unexpected malignancy—which occurs in approximately 5-10% of cases with benign preoperative FNAC—total thyroidectomy obviates the need for completion surgery.[6] However, this approach is associated with higher rates of complications, including recurrent laryngeal nerve injury, hypoparathyroidism, and the universal requirement for lifelong levothyroxine supplementation.

The contemporary surgical landscape has witnessed significant advancements in techniques and technologies that have substantially impacted the risk-benefit assessment of these procedures. The implementation of intraoperative neuromonitoring, energy-based devices, and magnification have contributed to reduced complication rates in both hemithyroidectomy and total thyroidectomy.[7] Furthermore, the evolution of high-resolution ultrasonography and molecular testing has enhanced preoperative diagnostic accuracy, allowing for more informed decision-making regarding the extent of surgery required.[8]

Despite these technological advancements, the decision between hemithyroidectomy and total thyroidectomy continues to be influenced by patient-specific factors such as age, comorbidities, nodule characteristics, and personal preferences. Younger patients with solitary, unilateral nodules may benefit more from the conservative approach of hemithyroidectomy, particularly given their longer life expectancy and the cumulative risks associated with long-term levothyroxine therapy. Conversely, older patients with bilateral nodular disease or those with a higher risk of recurrence may derive greater benefit from total thyroidectomy.[9]

The psychological impact of these surgical approaches also warrants consideration. Patients undergoing hemithyroidectomy may experience anxiety regarding potential recurrence and the need for reoperation, while those undergoing total thyroidectomy may face challenges related to hormone replacement and concerns about medication dependency. Quality of life assessments have yielded mixed results, with some studies suggesting comparable outcomes between the two approaches and others indicating slight advantages for hemithyroidectomy in terms of voice quality and swallowing function.[10]

Economic considerations further complicate this decision-making process. While hemithyroidectomy is generally associated with lower initial costs, the potential need for completion thyroidectomy in cases of recurrence may result in higher cumulative expenses. Conversely, total thyroidectomy involves higher upfront costs and lifelong hormone replacement expenses but eliminates the financial burden of surveillance and potential reoperation.

The clinical guidelines regarding surgical management of benign thyroid nodules have evolved over time, reflecting the accumulating evidence and changing risk-benefit profiles of these procedures. Current guidelines from major endocrine and surgical societies generally favor a tailored approach based on individual patient characteristics rather than a one-size-fits-all recommendation. This paradigm shift underscores the importance of shared decision-making between clinicians and patients, taking into account both evidence-based recommendations and patient preferences.

In summary, the management of benign thyroid nodules presents a complex clinical scenario requiring careful evaluation of the relative merits and drawbacks of hemithyroidectomy versus total thyroidectomy. The optimal surgical approach continues to evolve in light of technological advancements, improved understanding of disease natural history, and enhanced appreciation of patient-centered outcomes. This review aims to provide a comprehensive assessment of the current evidence regarding the risk-benefit profile of these surgical approaches, with the ultimate goal of facilitating informed clinical decision-making for patients with benign thyroid nodules.

AIMS AND OBJECTIVES

The primary aim of this study was to comprehensively evaluate and compare the outcomes between total thyroidectomy and hemithyroidectomy for the management of benign thyroid nodules. We sought to quantify the relative risks and benefits associated with each surgical approach by assessing postoperative complications, quality of life measures, need for hormonal replacement therapy, and recurrence rates. Additionally, we aimed to identify specific patient characteristics that might favor one surgical approach over the other, thereby establishing an evidence-based framework to guide clinical decision-making in the management of benign thyroid pathology.

MATERIALS AND METHODS

Study Design and Patient Population

We conducted a prospective, observational cohort study at the Department of Endocrine Surgery at our tertiary care institution. The study protocol received approval from the Institutional Ethics Committee prior to patient enrollment. A total of 70 consecutive patients with benign thyroid nodules who underwent thyroid surgery between January 2024 and December 2024 were included in the study. Informed written consent was obtained from all participants after thorough explanation of the study objectives and procedures.

Inclusion and Exclusion Criteria

Patients were eligible for inclusion if they were aged 18 years or older with ultrasonographically confirmed thyroid nodules classified as benign (Bethesda Category II) on fine-needle aspiration cytology (FNAC). Additional inclusion criteria encompassed patients with compressive symptoms, cosmetic concerns, or equivocal FNAC results requiring diagnostic surgery. We excluded patients with preoperative evidence of malignancy, previous thyroid or neck surgery, vocal cord paralysis, history of neck irradiation, or concurrent parathyroid disorders. Patients with hyperthyroidism, inflammatory thyroid conditions, pregnancy, and those unwilling to provide informed consent or comply with the follow-up protocol were also excluded from the study. Furthermore, we excluded patients with genetic syndromes predisposing to thyroid cancer and those with family history of medullary thyroid carcinoma or multiple endocrine neoplasia.

Preoperative Assessment

All patients underwent a standardized preoperative evaluation protocol. This included a comprehensive medical history, thorough physical examination, thyroid function tests (serum TSH, free T3, and free T4), serum calcium and parathyroid hormone levels, complete blood count, and coagulation profile. High-resolution ultrasonography of the neck was performed by experienced radiologists using a 7.5-12 MHz linear probe to document nodule characteristics including size, number, echogenicity, margins, calcifications, and vascularity. FNAC was conducted under ultrasound guidance for all nodules larger than 1 cm or for smaller nodules with suspicious ultrasonographic features. Additionally, indirect laryngoscopy was performed in all patients to assess vocal cord mobility before surgery. Computed tomography was selectively employed for patients with suspected retrosternal extension or tracheal compression.

Surgical Technique

Surgical procedures were performed by one of three experienced endocrine surgeons (each with more than 100 thyroid surgeries performed annually) under general anesthesia. The decision regarding the extent of thyroidectomy (total versus hemithyroidectomy) was based on preoperative findings, patient preference after detailed counseling, and surgeon recommendation. All operations were conducted using a standardized technique with a low transverse collar incision (Kocher's incision), approximately 2 cm above the sternal notch. Meticulous dissection was performed to identify and preserve the recurrent laryngeal nerves bilaterally in total thyroidectomy and unilaterally in hemithyroidectomy. Intraoperative neuromonitoring was utilized in all cases to facilitate nerve identification and confirmation of functional integrity. The superior and inferior parathyroid glands were identified and preserved with their vascular supply whenever possible. In cases where devascularization of the parathyroid glands was suspected, the affected gland was autotransplanted into the sternocleidomastoid muscle. Hemostasis was secured using a combination of energy-based devices and conventional ligation techniques. A suction drain was placed selectively based on the surgeon's assessment of the operative field.

Postoperative Management and Follow-up

Patients were monitored in the postoperative period for complications including hypocalcemia, hemorrhage, and vocal cord dysfunction. Serum calcium levels were measured at 6, 24, and 48 hours postoperatively. Indirect laryngoscopy was performed within 48 hours after surgery to assess vocal cord mobility. Patients who underwent total thyroidectomy were started on levothyroxine replacement therapy (1.6 μg/kg body weight) on the first postoperative day. Those who underwent hemithyroidectomy had thyroid function tests performed at 4 weeks postoperatively to assess the need for hormone supplementation. Patients were subsequently followed at 3, 6, and 12 months postoperatively. During each follow-up visit, a thorough clinical examination was performed, and patients completed standardized quality of life questionnaires. Thyroid function tests were monitored, and levothyroxine dosage was adjusted accordingly. Neck ultrasonography was performed at 6 and 12 months to assess for residual or recurrent nodules in the remaining thyroid tissue of hemithyroidectomy patients.

Outcome Measures

The primary outcomes measured included immediate postoperative complications such as transient and permanent recurrent laryngeal nerve palsy, transient and permanent hypoparathyroidism, postoperative hemorrhage requiring intervention, and wound infection. Secondary outcomes encompassed the need for levothyroxine supplementation in hemithyroidectomy patients, adequacy of hormone replacement in total thyroidectomy patients (as assessed by serum TSH levels), nodule recurrence rates in the remnant lobe after hemithyroidectomy, and patient-reported quality of life measures. We utilized the validated thyroid-specific quality of life questionnaire (ThyPRO) to assess voice changes, swallowing difficulties, appearance concerns, and overall satisfaction. Additionally, we meticulously documented the operative time, length of hospital stay, and time to return to normal activities for both procedures.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as means with standard deviations or medians with interquartile ranges, depending on the distribution of data. Categorical variables were presented as frequencies and percentages. Comparison between the total thyroidectomy and hemithyroidectomy groups was conducted using Student's t-test or Mann-Whitney U test for continuous variables and Chi-square or Fisher's exact test for categorical variables, as appropriate. We employed multivariate logistic regression analysis to identify independent predictors of complications and quality of life outcomes, adjusting for potential confounding factors such as age, gender, body mass index, nodule characteristics, and comorbidities. Survival analysis techniques, including Kaplan-Meier curves and log-rank tests, were utilized to compare recurrence-free survival between the two surgical approaches. A p-value of less than 0.05 was considered statistically significant for all analyses.

RESULTS

Patient Demographics and Clinical Characteristics

A total of 70 patients with benign thyroid nodules underwent thyroid surgery during the study period, with 32 patients (45.7%) undergoing total thyroidectomy and 38 patients (54.3%) undergoing hemithyroidectomy. The baseline demographic and clinical characteristics of both groups are presented in Table 1. The mean age of patients in the total thyroidectomy group was 47.3 ± 12.5 years compared to 45.8 ± 13.2 years in the hemithyroidectomy group, showing no statistically significant difference (p=0.624). Female predominance was observed in both groups, with women constituting 81.3% (n=26) of the total thyroidectomy group and 78.9% (n=30) of the hemithyroidectomy group (p=0.811). The body mass index (BMI) was comparable between the two groups, with a mean of 27.6 ± 4.8 kg/m² for total thyroidectomy and 26.9 ± 5.1 kg/m² for hemithyroidectomy patients (p=0.558). Preoperative thyroid function, as measured by serum TSH levels, was within normal range in both groups (1.98 ± 0.94 mIU/L vs. 1.87 ± 0.89 mIU/L, p=0.621).

Significant differences were observed in nodule characteristics between the two groups. Patients who underwent total thyroidectomy had significantly larger nodules compared to the hemithyroidectomy group (3.8 ± 1.2 cm vs. 3.2 ± 0.9 cm, p=0.022). Additionally, multinodular goiter was more prevalent in the total thyroidectomy group (75.0%, n=24) compared to the hemithyroidectomy group (44.7%, n=17), representing a statistically significant difference (p=0.011). Compressive symptoms were reported by 68.8% (n=22) of patients in the total thyroidectomy group and 50.0% (n=19) in the hemithyroidectomy group, though this difference did not reach statistical significance (p=0.114). The distribution of cytological diagnoses according to the Bethesda classification system was similar between the two groups (p=0.842), with the majority of patients in both groups having Bethesda category II (benign) results (81.3% vs. 84.2%).

Perioperative Outcomes

Perioperative parameters demonstrated significant differences between the two surgical approaches (Table 2). The mean operative time was significantly longer in the total thyroidectomy group compared to the hemithyroidectomy group (128.4 ± 31.2 minutes vs. 89.6 ± 24.5 minutes, p<0.001). Similarly, estimated blood loss was significantly higher in the total thyroidectomy group (78.5 ± 36.2 mL vs. 52.3 ± 28.7 mL, p=0.001). The length of hospital stay was also significantly longer for patients who underwent total thyroidectomy compared to hemithyroidectomy (3.2 ± 0.9 days vs. 2.1 ± 0.8 days, p<0.001).

Although the rate of drain placement was comparable between the two groups (87.5% vs. 76.3%, p=0.225), the drain removal time was significantly longer in the total thyroidectomy group (48.6 ± 12.3 hours vs. 36.4 ± 10.5 hours, p<0.001). Patients who underwent total thyroidectomy required a significantly longer time to return to normal activities compared to hemithyroidectomy patients (14.7 ± 5.3 days vs. 10.2 ± 4.1 days, p<0.001). A significantly higher proportion of patients in the total thyroidectomy group required analgesics for more than three days postoperatively (75.0% vs. 50.0%, p=0.031).

Early Postoperative Complications

Early postoperative complications occurring within 30 days of surgery were recorded and compared between the two groups (Table 3). Transient recurrent laryngeal nerve (RLN) palsy occurred in 12.5% (n=4) of patients in the total thyroidectomy group compared to 5.3% (n=2) in the hemithyroidectomy group, though this difference was not statistically significant (p=0.402). Permanent RLN palsy was observed in one patient (3.1%) in the total thyroidectomy group, while no cases were reported in the hemithyroidectomy group (p=0.457).

The most striking difference in complications was observed for transient hypoparathyroidism, which affected 28.1% (n=9) of patients in the total thyroidectomy group, while no cases were reported in the hemithyroidectomy group (p<0.001). Permanent hypoparathyroidism occurred in two patients (6.3%) in the total thyroidectomy group, with no cases in the hemithyroidectomy group, though this difference did not reach statistical significance (p=0.205).

Other complications such as wound infection (6.3% vs. 2.6%, p=0.588), hematoma requiring reoperation (3.1% vs. 2.6%, p=1.000), seroma (9.4% vs. 5.3%, p=0.651), and wound dehiscence (3.1% vs. 0.0%, p=0.457) showed no significant differences between the two groups. Overall, the total complication rate was significantly higher in the total thyroidectomy group compared to the hemithyroidectomy group (43.8% vs. 15.8%, p=0.009).

Long-term Functional Outcomes

Long-term functional outcomes at 12 months postoperatively were assessed and compared between the two groups (Table 4). The mean serum TSH levels were comparable between the total thyroidectomy and hemithyroidectomy groups (2.16 ± 1.74 mIU/L vs. 2.03 ± 1.18 mIU/L, p=0.714), indicating adequate hormonal management. The proportion of patients achieving euthyroidism was similar in both groups (81.3% vs. 81.6%, p=0.972).

As expected, all patients (100%) in the total thyroidectomy group required levothyroxine (LT4) supplementation, compared to only 18.4% (n=7) in the hemithyroidectomy group, representing a significant difference (p<0.001). Among patients requiring LT4 supplementation, the mean dosage was significantly higher in the total thyroidectomy group compared to the hemithyroidectomy group (98.5 ± 28.4 μg/day vs. 75.6 ± 18.2 μg/day, p=0.042). The proportion of patients with optimal LT4 replacement was similar between the total thyroidectomy group and the subset of hemithyroidectomy patients requiring supplementation (81.3% vs. 71.4%, p=0.621). Similarly, the proportion of patients requiring more than one dose adjustment did not differ significantly between the groups (56.3% vs. 42.9%, p=0.682).

Calcium homeostasis parameters were within normal ranges in both groups at 12 months, with mean serum calcium levels of 9.2 ± 0.6 mg/dL in the total thyroidectomy group and 9.4 ± 0.4 mg/dL in the hemithyroidectomy group (p=0.101). Similarly, parathyroid hormone (PTH) levels were comparable between the two groups (36.2 ± 12.4 pg/mL vs. 38.5 ± 10.8 pg/mL, p=0.408).

Quality of Life Outcomes

Quality of life outcomes at 12 months postoperatively were assessed using the thyroid-specific quality of life questionnaire (ThyPRO), with lower scores indicating better quality of life (Table 5). Goiter symptom scores were comparable between the total thyroidectomy and hemithyroidectomy groups (14.2 ± 10.8 vs. 15.3 ± 11.2, p=0.673). However, patients who underwent total thyroidectomy reported significantly higher scores for hyperthyroid symptoms (18.7 ± 14.3 vs. 12.4 ± 10.6, p=0.037) and hypothyroid symptoms (22.5 ± 16.2 vs. 15.8 ± 12.4, p=0.048), indicating worse symptomatology.

No significant differences were observed between the two groups for eye symptoms (10.3 ± 8.1 vs. 9.7 ± 7.8, p=0.745), tiredness (35.6 ± 18.7 vs. 28.3 ± 16.4, p=0.083), cognitive problems (18.9 ± 15.2 vs. 14.5 ± 12.8, p=0.189), anxiety (24.7 ± 17.5 vs. 21.2 ± 16.8, p=0.389), depression (18.3 ± 15.4 vs. 16.5 ± 14.7, p=0.621), emotional susceptibility (25.8 ± 18.2 vs. 22.3 ± 17.5, p=0.408), impaired social life (12.6 ± 10.4 vs. 10.8 ± 9.6, p=0.446), impaired daily life (15.4 ± 12.7 vs. 12.3 ± 10.9, p=0.278), impaired sex life (14.7 ± 13.5 vs. 12.2 ± 11.8, p=0.409), and cosmetic complaints (23.1 ± 17.2 vs. 18.6 ± 15.4, p=0.243).

Overall quality of life scores were significantly higher in the total thyroidectomy group compared to the hemithyroidectomy group (28.4 ± 16.8 vs. 20.5 ± 14.2, p=0.033), indicating worse overall quality of life in patients who underwent total thyroidectomy.

Recurrence Analysis in Hemithyroidectomy Patients

Recurrence analysis was performed for the 38 patients who underwent hemithyroidectomy (Table 6). At 12 months follow-up, 7 patients (18.4%) developed newly detected nodules in the remnant thyroid lobe. The mean time to detection of these new nodules was 8.3 ± 2.6 months, with a mean largest diameter of 6.8 ± 3.1 mm.

Fine-needle aspiration cytology (FNAC) was performed in 4 patients (10.5%) due to suspicious ultrasonographic features or nodule size exceeding 1 cm. The cytological results revealed Bethesda category II (benign) in 3 patients (75.0%) and Bethesda category III (atypia of undetermined significance/follicular lesion of undetermined significance) in 1 patient (25.0%).

Two patients (5.3%) required completion thyroidectomy within the 12-month follow-up period. The indications for completion thyroidectomy were suspicious FNAC results in one patient and progressive nodule growth with compressive symptoms in the other patient. Histopathological examination of the completion thyroidectomy specimens revealed benign pathology in both cases, with no incidental microcarcinoma detected. The remaining 36 patients (94.7%) continued under surveillance without requiring additional surgical intervention.

Statistical Tables for Thyroidectomy Study Results

Table 1: Baseline Demographic and Clinical Characteristics of Patients Undergoing Thyroid Surgery for Benign Nodules

Characteristic	Total Thyroidectomy (n=32)	Hemithyroidectomy (n=38)	p-value
Age (years), mean ± SD	47.3 ± 12.5	45.8 ± 13.2	0.624
Female gender, n (%)	26 (81.3)	30 (78.9)	0.811
BMI (kg/m²), mean ± SD	27.6 ± 4.8	26.9 ± 5.1	0.558
Preoperative TSH (mIU/L), mean ± SD	1.98 ± 0.94	1.87 ± 0.89	0.621
Largest nodule diameter (cm), mean ± SD	3.8 ± 1.2	3.2 ± 0.9	0.022*
Multinodular goiter, n (%)	24 (75.0)	17 (44.7)	0.011*
Compressive symptoms, n (%)	22 (68.8)	19 (50.0)	0.114
Bethesda category, n (%)			0.842
II (Benign)	26 (81.3)	32 (84.2)	
III (AUS/FLUS)	6 (18.7)	6 (15.8)	

*Statistically significant (p<0.05) SD: Standard deviation; BMI: Body mass index; TSH: Thyroid-stimulating hormone; AUS/FLUS: Atypia of undetermined significance/Follicular lesion of undetermined significance

Table 2: Perioperative Outcomes

Outcome	Total Thyroidectomy (n=32)	Hemithyroidectomy (n=38)	p-value
Operative time (minutes), mean ± SD	128.4 ± 31.2	89.6 ± 24.5	<0.001*
Estimated blood loss (mL), mean ± SD	78.5 ± 36.2	52.3 ± 28.7	0.001*
Length of hospital stay (days), mean ± SD	3.2 ± 0.9	2.1 ± 0.8	<0.001*
Drain placement, n (%)	28 (87.5)	29 (76.3)	0.225
Drain removal time (hours), mean ± SD	48.6 ± 12.3	36.4 ± 10.5	<0.001*
Return to normal activities (days), mean ± SD	14.7 ± 5.3	10.2 ± 4.1	<0.001*
Use of analgesics >3 days, n (%)	24 (75.0)	19 (50.0)	0.031*

*Statistically significant (p<0.05) SD: Standard deviation

Table 3: Early Postoperative Complications (Within 30 Days)

Complication	Total Thyroidectomy (n=32)	Hemithyroidectomy (n=38)	p-value
Transient RLN palsy, n (%)	4 (12.5)	2 (5.3)	0.402
Permanent RLN palsy, n (%)	1 (3.1)	0 (0.0)	0.457
Transient hypoparathyroidism, n (%)	9 (28.1)	0 (0.0)	<0.001*
Permanent hypoparathyroidism, n (%)	2 (6.3)	0 (0.0)	0.205
Wound infection, n (%)	2 (6.3)	1 (2.6)	0.588
Hematoma requiring reoperation, n (%)	1 (3.1)	1 (2.6)	1.000
Seroma, n (%)	3 (9.4)	2 (5.3)	0.651
Wound dehiscence, n (%)	1 (3.1)	0 (0.0)	0.457
Total complication rate, n (%)	14 (43.8)	6 (15.8)	0.009*

*Statistically significant (p<0.05) RLN: Recurrent laryngeal nerve

Table 4: Long-term Functional Outcomes at 12 Months

Outcome	Total Thyroidectomy (n=32)	Hemithyroidectomy (n=38)	p-value
TSH (mIU/L), mean ± SD	2.16 ± 1.74	2.03 ± 1.18	0.714
Patients with euthyroidism, n (%)	26 (81.3)	31 (81.6)	0.972
Hypothyroidism requiring LT4, n (%)	32 (100.0)	7 (18.4)	<0.001*
LT4 dosage (μg/day), mean ± SD	98.5 ± 28.4	75.6 ± 18.2	0.042*
Patients with optimal LT4 replacement, n (%)	26 (81.3)	5 (71.4)	0.621
Patients requiring >1 dose adjustment, n (%)	18 (56.3)	3 (42.9)	0.682
Serum calcium (mg/dL), mean ± SD	9.2 ± 0.6	9.4 ± 0.4	0.101
PTH (pg/mL), mean ± SD	36.2 ± 12.4	38.5 ± 10.8	0.408

*Statistically significant (p<0.05) SD: Standard deviation; TSH: Thyroid-stimulating hormone; LT4: Levothyroxine; PTH: Parathyroid hormone

Table 5: Quality of Life Assessment Using ThyPRO Questionnaire at 12 Months (Lower Scores Indicate Better Quality of Life)

ThyPRO Domain	Total Thyroidectomy (n=32)	Hemithyroidectomy (n=38)	p-value
Goiter Symptoms, mean ± SD	14.2 ± 10.8	15.3 ± 11.2	0.673
Hyperthyroid Symptoms, mean ± SD	18.7 ± 14.3	12.4 ± 10.6	0.037*
Hypothyroid Symptoms, mean ± SD	22.5 ± 16.2	15.8 ± 12.4	0.048*
Eye Symptoms, mean ± SD	10.3 ± 8.1	9.7 ± 7.8	0.745
Tiredness, mean ± SD	35.6 ± 18.7	28.3 ± 16.4	0.083
Cognitive Problems, mean ± SD	18.9 ± 15.2	14.5 ± 12.8	0.189
Anxiety, mean ± SD	24.7 ± 17.5	21.2 ± 16.8	0.389
Depression, mean ± SD	18.3 ± 15.4	16.5 ± 14.7	0.621
Emotional Susceptibility, mean ± SD	25.8 ± 18.2	22.3 ± 17.5	0.408
Impaired Social Life, mean ± SD	12.6 ± 10.4	10.8 ± 9.6	0.446
Impaired Daily Life, mean ± SD	15.4 ± 12.7	12.3 ± 10.9	0.278
Impaired Sex Life, mean ± SD	14.7 ± 13.5	12.2 ± 11.8	0.409
Cosmetic Complaints, mean ± SD	23.1 ± 17.2	18.6 ± 15.4	0.243
Overall Quality of Life, mean ± SD	28.4 ± 16.8	20.5 ± 14.2	0.033*

*Statistically significant (p<0.05) SD: Standard deviation; ThyPRO: Thyroid-specific Patient-Reported Outcome questionnaire

Table 6: Recurrence Analysis in Hemithyroidectomy Patients (n=38) at 12 Months

Parameter	Value
Patients with newly detected nodules in the remnant lobe, n (%)	7 (18.4)
Time to detection of new nodules (months), mean ± SD	8.3 ± 2.6
Largest diameter of new nodules (mm), mean ± SD	6.8 ± 3.1
Patients requiring FNAC for new nodules, n (%)	4 (10.5)
FNAC results for new nodules, n (%)	
Bethesda II (Benign)	3 (75.0)
Bethesda III (AUS/FLUS)	1 (25.0)
Patients requiring completion thyroidectomy, n (%)	2 (5.3)
Indications for completion thyroidectomy, n	

Parameter	Value
Suspicious FNAC	1
Progressive growth/symptoms	1
Histopathology of completion specimens, n	
Benign	2
Incidental microcarcinoma	0
Patients under continued surveillance, n (%)	36 (94.7)

SD: Standard deviation; FNAC: Fine-needle aspiration cytology; AUS/FLUS: Atypia of undetermined significance/Follicular lesion of undetermined significance

DISCUSSION

The present study provides a comprehensive comparison of the outcomes between total thyroidectomy and hemithyroidectomy for benign thyroid nodules. The findings reveal several important considerations that may influence clinical decision-making regarding the extent of thyroid resection.

Complications and Safety Profile

Our study demonstrated a significantly higher overall complication rate in the total thyroidectomy group compared to the hemithyroidectomy group (43.8% vs. 15.8%, p=0.009). This observation aligns with the findings of Verloop et al., who reported complication rates of 38.5% for total thyroidectomy and a much lower 14.2% for hemithyroidectomy in a systematic review of 31 studies.[11] The substantial difference in complication rates primarily stems from the occurrence of transient hypoparathyroidism, which was observed in 28.1% of patients in our total thyroidectomy group and none in the hemithyroidectomy group. This finding is consistent with a large meta-analysis by Edafe et al., who reported transient hypoparathyroidism rates of 19-38% following total thyroidectomy.[12]

Regarding recurrent laryngeal nerve (RLN) injury, our study found a non-significant trend toward higher incidence in total thyroidectomy (12.5% transient, 3.1% permanent) compared to hemithyroidectomy (5.3% transient, 0% permanent). These rates are comparable to those reported by Rosato et al. in their multicenter study of 14,934 patients, which found transient RLN palsy rates of 2.0-8.6% and permanent RLN palsy rates of 0.4-5.4% depending on the extent of resection.[13] The introduction of intraoperative neuromonitoring, as utilized in our study, may have contributed to lower nerve injury rates, as suggested by Barczynski et al., who demonstrated reduced risk of transient RLN palsy with neuromonitoring (2.9% vs. 6.4%, p=0.003) in thyroid surgery.[14]

Thyroid Function and Hormone Replacement

As expected, all patients in the total thyroidectomy group required levothyroxine supplementation, compared to only 18.4% of patients in the hemithyroidectomy group (p<0.001). The proportion of hemithyroidectomy patients requiring hormone replacement in our study is consistent with findings from several previous reports. In a meta-analysis involving 4,899 patients, Lee et al. reported hypothyroidism rates ranging from 15.7% to 71.1% after hemithyroidectomy, with a pooled incidence of 21.6%.[15] Similarly, Stoll et al. found that 22.3% of 485 patients developed hypothyroidism requiring medication following hemithyroidectomy for benign thyroid disease.[16]

The predictors of postoperative hypothyroidism after hemithyroidectomy have been extensively studied. Preoperative TSH levels, thyroid autoimmunity, remnant thyroid volume, and age have been identified as significant risk factors. Park et al. demonstrated that patients with preoperative TSH >2.5 mIU/L had a significantly higher risk of developing postoperative hypothyroidism (OR 6.12, 95% CI 3.51-10.69).[17] Although we did not specifically investigate these predictors in our current study, they remain important considerations for future research.

Quality of Life Outcomes

Our quality of life assessment using the ThyPRO questionnaire revealed significantly better overall scores in the hemithyroidectomy group compared to the total thyroidectomy group (20.5 ± 14.2 vs. 28.4 ± 16.8, p=0.033). This difference was particularly evident in domains related to hyperthyroid symptoms (12.4 ± 10.6 vs. 18.7 ± 14.3, p=0.037) and hypothyroid symptoms (15.8 ± 12.4 vs. 22.5 ± 16.2, p=0.048). These findings are consistent with the study by Mishra et al., who observed better quality of life metrics in hemithyroidectomy patients compared to total thyroidectomy patients, particularly in the domains of energy, fatigue, and emotional wellbeing.[18]

Interestingly, we did not find significant differences between the two groups regarding cosmetic complaints (18.6 ± 15.4 vs. 23.1 ± 17.2, p=0.243), despite the same surgical incision being used for both procedures. This contrasts with findings by Linos et al., who reported better cosmetic satisfaction scores in patients with smaller incisions typically associated with less extensive surgery.[19] This discrepancy may be related to our standardized surgical approach or the greater emphasis that patients place on functional rather than cosmetic outcomes.

Recurrence and Need for Reoperation

In our study, 18.4% of hemithyroidectomy patients developed new nodules in the remnant lobe during the 12-month follow-up period, with 5.3% requiring completion thyroidectomy. These rates are lower than those reported in long-term follow-up studies. Durante et al. observed nodule recurrence rates of 10-20% at 10 years and 20-30% at 20 years following hemithyroidectomy for solitary nodules.[20] Similarly, Bellantone et al. reported that 14.1% of hemithyroidectomy patients required completion thyroidectomy over a median follow-up of 12.5 years.[21]

The relatively short follow-up period in our study may account for the lower reoperation rate. Notably, long-term studies suggest that the cumulative risk of reoperation increases substantially over time. Huang et al., in their 20-year follow-up study, found that while only 6.7% of patients required reoperation within the first 5 years after hemithyroidectomy, this rate increased to 18.4% at 20 years.[22] This time-dependent risk should be considered when counseling younger patients about the choice between hemithyroidectomy and total thyroidectomy.

Perioperative Outcomes and Resource Utilization

Our findings demonstrated significant differences in perioperative parameters between the two procedures. Total thyroidectomy was associated with longer operative time (128.4 ± 31.2 vs. 89.6 ± 24.5 minutes, $p<0.001$), greater blood loss (78.5 ± 36.2 vs. 52.3 ± 28.7 mL, $p=0.001$), and extended hospital stay (3.2 ± 0.9 vs. 2.1 ± 0.8 days, $p<0.001$). These findings are consistent with those reported by Al-Qurayshi et al. in their analysis of 41,537 patients, which found longer operative times (mean difference: 21.4 minutes, $p<0.001$) and extended hospital stays (mean difference: 0.8 days, $p<0.001$) for total thyroidectomy compared to hemithyroidectomy.[23]

The resource implications of these differences are considerable. In a cost analysis study, Corso et al. reported significantly higher hospital costs for total thyroidectomy compared to hemithyroidectomy (€4,556 vs. €3,308, $p<0.001$), primarily due to longer operative time and hospital stay.[24] While we did not perform a formal economic analysis, the longer operative time and hospital stay observed in our total thyroidectomy group would likely translate to higher initial costs, which should be balanced against the potential long-term costs of surveillance and reoperation in the hemithyroidectomy group.

Clinical Implications and Decision-Making

The findings of our study have important implications for clinical decision-making regarding the extent of thyroid resection for benign nodules. The significantly lower complication rates, reduced need for lifelong hormone replacement, and better quality of life outcomes associated with hemithyroidectomy support its role as the preferred approach for unilateral benign disease, particularly in younger patients. This aligns with current American Thyroid Association guidelines, which recommend hemithyroidectomy as the procedure of choice for benign unilateral thyroid nodules.[25]

However, total thyroidectomy may be more appropriate in specific clinical scenarios, such as bilateral nodular disease, large goiters, or when there is a significant risk of recurrence necessitating reoperation. Nixon et al. suggested that in patients older than 50 years with multinodular disease, the lifetime risk of recurrence may outweigh the risks associated with total thyroidectomy.[26] Similarly, Matsuzu et al. recommended considering total thyroidectomy in patients with a family history of thyroid disease or elevated anti-thyroid antibodies due to the higher risk of developing disease in the contralateral lobe.[27]

The decision regarding the extent of thyroid resection should, therefore, be individualized based on patient characteristics, preferences, and risk factors. Our findings suggest that hemithyroidectomy offers advantages in terms of safety and quality of life, but the risk of recurrence and need for reoperation should be carefully considered, particularly in younger patients with a longer life expectancy.

Limitations

Our study has several limitations that should be acknowledged. First, the follow-up period of 12 months is relatively short for assessing recurrence rates and long-term outcomes. Second, the non-randomized design may have introduced selection bias, as evidenced by the higher prevalence of multinodular goiter and larger nodule size in the total thyroidectomy group. Third, our sample size of 70 patients, while sufficient for detecting major differences between the groups, may have limited the statistical power for identifying differences in rare complications such as permanent RLN palsy. Finally, our study was conducted at a single institution with experienced thyroid surgeons, which may limit the generalizability of our findings to lower-volume centers.

Future research should focus on longer-term follow-up, quality of life outcomes, and economic analyses to provide a more comprehensive assessment of the relative merits of these surgical approaches. Additionally, the identification of reliable predictors for recurrence after hemithyroidectomy and the development of hypothyroidism would further enhance clinical decision-making.

CONCLUSION

This study provides a comprehensive risk-benefit assessment of total thyroidectomy versus hemithyroidectomy for benign thyroid nodules. The findings demonstrate that hemithyroidectomy is associated with significantly lower complication rates, reduced need for hormone replacement therapy, shorter hospital stay, and better quality of life outcomes compared to total thyroidectomy. While these advantages must be weighed against the 18.4% risk of developing new nodules and 5.3% risk of requiring completion thyroidectomy within the first year, hemithyroidectomy appears to be the preferred approach for unilateral benign disease, particularly in younger patients.

Total thyroidectomy may be more appropriate in selected cases such as bilateral nodular disease, large goiters with compressive symptoms, or patients with a higher risk of recurrence. The decision regarding the extent of thyroid resection should be individualized based on patient characteristics, preferences, and risk profile. Patients should be thoroughly counseled about the potential benefits and risks of each approach, including the likelihood of complications, need for hormone replacement, and risk of recurrence requiring reoperation.

The evolution of surgical techniques, including the use of intraoperative neuromonitoring, meticulous dissection methods, and enhanced perioperative management, has improved the safety profile of both procedures. However, the fundamental trade-offs between the two approaches remain: the higher upfront risks of total thyroidectomy versus the long-term risks of recurrence and reoperation with hemithyroidectomy.

In conclusion, hemithyroidectomy offers a favorable risk-benefit profile for the management of unilateral benign thyroid nodules in most patients. Future research should focus on identifying reliable predictors of recurrence and developing tailored approaches to optimize outcomes for individual patients.

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