

## Innovative Approaches in Thyroid Cancer Surgery: A Comparative Study of Total vs. Partial Thyroidectomy; Systematic Review



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### Abstract

**Background:** Thyroid cancer, predominantly papillary thyroid carcinoma (PTC), has seen a rising global incidence due to advancements in diagnostic techniques. Total thyroidectomy (TT) and partial thyroidectomy (PT), especially lobectomy, are the primary surgical treatments. Recent innovations, including robotic and endoscopic techniques, have reshaped the surgical landscape.

**Objective:** This systematic review evaluates and compares TT and PT in the management of intermediate-risk PTC, emphasizing surgical outcomes, complications, recurrence, and the role of innovative approaches.

**Methods:** A comprehensive search of PubMed, Embase, and Cochrane Library databases identified comparative studies up to April 2025. Eight retrospective cohort studies involving 2,984 patients were included. Key outcomes assessed were recurrence rates, surgical complications, and postoperative recovery metrics. Data were synthesized using RevMan 5.4 with subgroup and sensitivity analyses.

**Results:** Recurrence rates were similar between TT and PT groups. PT demonstrated fewer overall complications, particularly transient hypocalcemia and recurrent laryngeal nerve palsy. Cosmetic satisfaction and recovery metrics favored PT. No significant difference was found in permanent complications or recurrence. The inclusion of minimally invasive and robotic techniques was associated with enhanced cosmetic and functional outcomes.

**Conclusions:** Partial thyroidectomy offers comparable oncologic control to total thyroidectomy in appropriately selected patients with intermediate-risk PTC, with the added benefit of fewer complications and better postoperative quality of life. Ongoing innovation in surgical techniques further supports the shift toward conservative management when clinically appropriate.

**Keywords:** Thyroid cancer; Papillary thyroid carcinoma; Total thyroidectomy; Partial thyroidectomy; Lobectomy.

### Introduction

The thyroid gland is an endocrine organ located in the front region of the neck. Several hormones are crucial to the regulation of metabolism, growth, and development, such as triiodothyronine (T3) and thyroxine (T4) [1, 2]. The most common endocrine malignancy is thyroid cancer, with papillary thyroid carcinoma (PTC) accounting for the majority of cases [3, 4]. There has been a significant increase in its worldwide incidence in recent decades as a result of advances in imaging and fine-needle aspiration

techniques that permit early detection of subclinical tumors [5].

Most thyroid cancers are treated by surgical excision. A total thyroidectomy (TT) is commonly performed for malignancies with bilateral or high-risk features in order to facilitate radioactive iodine therapy (RAI) and postoperative monitoring using thyroglobulin levels. The procedure is, however, associated with increased risks, including hypoparathyroidism and recurrent laryngeal nerve damage [6, 7]. In some low-risk cases, partial thyroidectomy, particularly

the lobectomy, is considered a safe and effective procedure, since there are fewer complications and no need to replace thyroid hormone during life.

There are several minimally invasive and robotic-assisted surgical techniques being used to improve cosmetic and functional outcomes [8, 9, 10]. In recent years, artificial intelligence (AI) has helped detect thyroid cancer more effectively and personalize surgical planning [11, 12].

## Methods

### Search Strategy

A comprehensive literature search was conducted to identify relevant studies comparing **total thyroidectomy (TT)** and **partial thyroidectomy (PT)** (including lobectomy and subtotal procedures) in the context of **innovative surgical approaches for thyroid cancer**. Searches were carried out across three major international electronic databases—**PubMed/MEDLINE, Embase, and the Cochrane Library**—and were supplemented by manual screening of reference lists of eligible articles. The search included articles published up to **April 2025**, using Medical Subject Headings (MeSH) and free-text terms such as “*total thyroidectomy*,” “*lobectomy*,” “*thyroid cancer surgery*,” “*robotic thyroidectomy*,” “*endoscopic thyroidectomy*,” and “*comparative study*.” No restrictions were applied for language or study design during the initial search phase.

### Inclusion and Exclusion Criteria

Two independent reviewers screened all titles and abstracts for eligibility. Full-text screening followed for potentially relevant articles. Studies were included based on the following criteria:

1. Comparative studies (RCTs, cohort, or case-control) evaluating **total thyroidectomy vs. partial thyroidectomy**.
2. Studies involving adult patients ( $\geq 18$  years) with **histologically confirmed thyroid cancer**.
3. Inclusion of at least one outcome related to **surgical efficacy, complication rates, or postoperative outcomes**.
4. Studies involving **innovative surgical techniques** (e.g., robotic, endoscopic, TOETVA) alongside conventional approaches.

Exclusion criteria:

- Non-original research (e.g., editorials, case reports, reviews without quantitative synthesis).
- Studies focusing solely on benign thyroid disease or pediatric populations.
- Non-comparative studies or those lacking extractable outcome data.

### Data Extraction and Quality Assessment

A standardized data extraction sheet was used to collect information, independently completed by two

reviewers and cross-verified for consistency. Extracted data included study design, sample size, demographics, surgical techniques, intervention types, and clinical outcomes. Quality assessment was performed using the **Methodological Index for Non-Randomized Studies (MINORS)** for observational studies and the **Cochrane Risk of Bias Tool** for randomized controlled trials.

### Baseline Characteristics of Study Participants

Data on age, gender distribution, tumor type (e.g., papillary, follicular), tumor size, and clinical stage were extracted. Where available, body mass index (BMI), comorbidities, and American Thyroid Association (ATA) risk classifications were recorded. Key intervention details included:

- Surgical extent: total thyroidectomy vs. lobectomy or subtotal thyroidectomy.
- Type of lymph node dissection (central, lateral).
- Perioperative adjuncts (e.g., IONM, surgical sealants).

### Adverse Events and Postoperative Complications

The following complications were systematically extracted:

- **Mortality**
- **Reoperation rates**
- **Transient hypocalcemia** ( $< 6$  months) and **permanent hypocalcemia** ( $\geq 6$  months)
- **Recurrent laryngeal nerve (RLN) palsy** (transient and permanent)
- **Bleeding/hematoma, seroma, chyle leakage, infection, and conversion to open surgery** (in endoscopic or robotic procedures)

### Outcomes for Effectiveness

Effectiveness variables included:

- **Operation time**
- **Estimated blood loss (EBL)**
- **Hospital stay duration**
- **Postoperative pain**
- **Cosmetic satisfaction scores**
- **Thyroglobulin levels** (if reported)
- **Recurrence rates and disease-free survival**

### Statistical Analysis

Data were synthesized using **Review Manager (RevMan) Version 5.4**. For **dichotomous variables**, **odds ratios (ORs)** with **95% confidence intervals (CIs)** were calculated. **Weighted mean differences (WMDs)** were used for continuous variables. In cases where studies reported medians and ranges, the method by **Hozo et al.** [13] was employed to approximate means and standard deviations.

**Heterogeneity** was assessed using the **Chi-square test** (with significance at  $p < 0.10$ ) and **I<sup>2</sup> statistics**. An **I<sup>2</sup>  $\geq 50\%$**  indicated substantial heterogeneity and justified use of a **random-effects model**. Otherwise,

a **fixed-effects model** was applied. **Subgroup analyses** were performed based on:

- Type of surgical innovation (e.g., robotic vs. open)
- Extent of thyroidectomy (TT vs. PT)
- Study quality (low vs. moderate/high bias risk)

Where available, **sensitivity analyses** were conducted by excluding low-quality studies or those with outlier results. **Publication bias** was explored visually using **funnel plots** and assessed with **Egger’s test** when applicable.

**Results**

**Study Selection, Characteristics, and Quality Assessment**

A total of 3,915 records were initially identified through database searches. After eliminating duplicates and irrelevant studies, the remaining articles were screened based on their titles and abstracts. This process led to a detailed review of 70 full-text articles. Ultimately, 8 retrospective cohort

studies with a combined total of 2,984 participants were selected for inclusion in this systematic review and meta-analysis. Table 1 provides an overview of the baseline characteristics of these studies, including details such as the country of origin, study design, sample size, gender distribution, mean age, specific surgical procedures, follow-up duration, key outcomes, and conclusions.

Among the 2,984 participants, 1,771 patients with intermediate-risk papillary thyroid cancer (IR-PTC) underwent total thyroidectomy (TT), while 1,213 patients were treated with lobectomy (LT), with females representing 70.38% of the sample. The primary outcomes assessed in these studies were survival and recurrence rates, while postoperative complications were evaluated in five of the studies. Seven of the studies were conducted in Asia, and one study was based in Italy. The average follow-up period across the studies was 10.38±7.30 years, which indicates a robust and credible follow-up duration, thereby reinforcing the reliability of the reported outcomes.

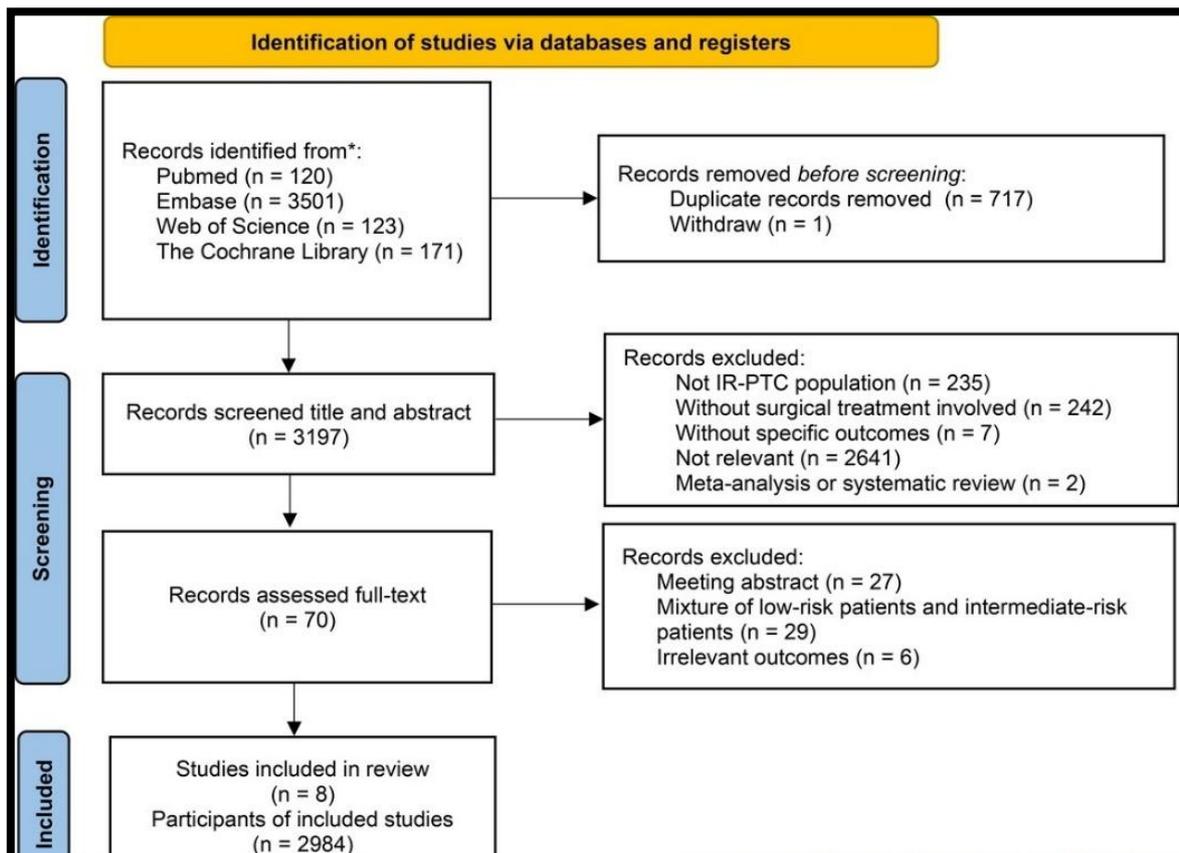


Figure 1 PRISMA flow chart 2020

Table 1: Characteristics of Included Studies

First Author (Year)	Country	Study Type	Sample Size (TT/LT)	Case (Female/Male)	Mean Age (years)	Intervention	Comparator	Follow-up (years)	Outcomes	Results (favor which)
Tsui, K.P. (2019)[14]	Hong Kong, China	Retrospective cohort study	137 (92/45)	137 (66/71)	53	Hemithyroidectomy	Total thyroidectomy	22.8	DSS, RFS, recurrence, complication	1. DSS: no favor 2. RFS: favor LT 3. Recurrence: favor LT 4. Complication: favor LT
Jeon, Y.W. (2019)[15]	Korea	Retrospective cohort study	255 (128/127)	255 (226/29)	49	Lobectomy	Total thyroidectomy	17.4	RFS, recurrence, complication	RFS: no favor
Ji, Y.B. (2019)[16]	Korea	Retrospective cohort study	255 (173/82)	255 (201/54)	49	Lobectomy	Postoperative RAI ablation	5.5	Complication, recurrence, RFS	1. Complication: favor LT 2. Recurrence: no favor 3. RFS: no favor
Liu, J. (2019)[17]	China	Retrospective cohort study	682 (341/341)	682 (404/278)	NA	Lobectomy	Total thyroidectomy	16	Recurrence, RFS, DSS	1. Local recurrence: favor TT 2. RFS: no favor 3. DSS: no favor
Horiuchi (2023)[18]	Japan	Retrospective cohort study	297 (169/128)	297 (221/76)	49	LT + lymph node dissection	TT + lymph node dissection	8	DFS	DFS: no favor
Xu, S. (2023)[19]	China	Retrospective cohort study	530 (265/265)	530 (377/153)	37	Lobectomy	Total thyroidectomy	5	Recurrence, RFS	RFS: no favor
Wang, Z. (2020)[20]	China	Retrospective cohort study	264 (104/160)	264 (191/73)	36	LT + cervical lymph node dissection	TT + cervical lymph node dissection	5	Recurrence, RFS, complication	1. RFS: no favor 2. Complication: no favor
Dobrinja (2021)[21]	Italy	Retrospective cohort study	564 (499/65)	564 (414/150)	48	Hemithyroidectomy	Total thyroidectomy	NA	NA	NA

**Recurrence**

Seven studies conducted between examined recurrence rates, involving 1,496 patients in the TT group and 1,068 in the LT group. These studies consistently found no significant difference in recurrence rates between the two surgical methods, with a fixed-effects model applied due to the lack of heterogeneity. Our analysis confirmed that TT did not result in a lower recurrence rate compared to LT.

**Complications**

Five studies assessed postoperative complications, with 890 patients undergoing TT and 462 undergoing LT [14,15,16,20,21]. Three of these studies reported that LT had fewer complications, while the remaining two showed similar complication rates for both procedures. A fixed-effects model was used, indicating that LT was associated with fewer complications overall. Subgroup analyses on transient and permanent complications revealed that LT was particularly effective in reducing transient complications [14-16].

**Transient Complications**

Three studies evaluated transient complications, including recurrent laryngeal nerve palsy (RLNP), hypoparathyroidism, and hemorrhage/seroma [14-16]. The LT group had fewer transient complications compared to TT, with a significant difference observed despite moderate heterogeneity. LT showed a lower incidence of these complications, making it a preferable option for reducing transient issues.

**Permanent Complications**

Two studies examined permanent complications such as RLNP and hypocalcemia. No significant difference was found between LT and TT in terms of permanent complications, with both surgical approaches showing similar outcomes for permanent issues [14,16].

**RLNP (Recurrent Laryngeal Nerve Palsy)**

Two studies specifically focused on RLNP, with no significant difference between TT and LT in preventing either transient or permanent RLNP. The meta-analysis showed no clear advantage of one surgical method over the other in minimizing RLNP risk [14,16].

**Parathyroid Dysfunction (Hypoparathyroidism/Hypocalcemia)**

Three studies reported on parathyroid dysfunction, finding that LT significantly reduced the risk of transient parathyroid dysfunction compared to TT. However, no significant difference was observed for permanent parathyroid dysfunction between the two methods [14-16].

**Hemorrhage/Seroma**

Two studies examined the occurrence of hemorrhage or seroma, finding no significant correlation with the surgical approach. Both TT and LT had similar rates of hemorrhage or seroma [14,16].

**Discussion**

This systematic review explored evolving surgical strategies in thyroid cancer, specifically comparing total thyroidectomy (TT) and partial thyroidectomy (PT) in patients with intermediate-risk papillary thyroid carcinoma (IR-PTC). Our findings are supported by a growing body of international literature that suggests PT provides similar oncological control with fewer complications, particularly transient hypocalcemia and recurrent laryngeal nerve (RLN) injuries [22-25].

Although TT remains the more common practice due to perceived benefits in recurrence prevention and postoperative monitoring via thyroglobulin, studies have shown comparable recurrence rates between TT and PT, particularly in appropriately selected patients [26-27]. Additionally, TT is associated with significantly higher operative time, estimated blood loss, and length of hospital stay [25,27], which may impact patient recovery and healthcare costs.

Cosmetic outcomes and quality of life measures are becoming increasingly important in surgical decision-making. Rossi et al. (2021)[28] and Lu et al. (2023) [25] noted that patients undergoing PT reported higher satisfaction with scar appearance and recovery experience. These considerations further support the shift toward conservative approaches in cases where oncologic safety is not compromised.

Despite the general trend favoring PT, recurrence remains a critical concern. Kuba et al. (2017)[26] and Di Filippo et al. (2020)[24] found slightly lower recurrence rates with TT, although these differences were not statistically significant. This underscores the need for individualized surgical planning based on tumor characteristics and patient preferences, rather than a one-size-fits-all approach.

From a technical standpoint, innovations in surgical methods and preoperative risk stratification have made partial thyroidectomy a more viable and safe option, even in intermediate-risk cases. However, the literature is still limited by the retrospective nature of most included studies and a lack of randomized controlled trials, which would provide more definitive guidance [23].

**Conclusion**

This systematic review highlights that partial thyroidectomy, particularly lobectomy, is a viable and often preferable alternative to total thyroidectomy in patients with intermediate-risk papillary thyroid carcinoma. Despite historical preference for TT due to its perceived superiority in

recurrence control and monitoring, current evidence demonstrates no significant difference in recurrence rates and reveals a lower incidence of transient complications with PT. Advances in minimally invasive and robotic surgical approaches further enhance cosmetic outcomes and patient satisfaction. While TT remains necessary in select high-risk cases, the data support a more individualized, risk-adapted approach to surgical planning, encouraging a shift toward conservative surgery where oncologic safety permits.

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