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Mini-incision Thyroidectomy in Contemporary Practice: Safety, Efficiency, and Cosmetic Outcomes from a Large Consecutive Cohort

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Abstract

Background

Open thyroidectomy remains the standard procedure for most thyroid diseases, but may result in a visible cervical scar that affects patient satisfaction. Mini-incision thyroidectomy (MIT) is a reduced-access modification of open surgery designed to limit incision length while preserving conventional anatomy and operative principles. Evidence supporting its routine use remains limited.

Methods

We conducted a retrospective cohort study of all consecutive patients who underwent MIT at a high-volume endocrine surgery unit between December 2014 and December 2019. Demographic data, ultrasound findings, operative details, incision length, postoperative complications, and patient-reported cosmetic satisfaction were analyzed. All procedures were performed by the same experienced team using a standardized, non-endoscopic technique.

Results

A total of 209 patients were included (79.9% female; mean age 39.6 years). Mean thyroid volume was 35.1 mL, and mean dominant nodule size was 2.56 cm. MIT was completed in all cases through a short cervical incision (mean 2.81 cm) without conversion. Mean operative time was 59.4 minutes, with minimal blood loss. Transient hypocalcemia occurred in 9.6% of patients and transient recurrent laryngeal nerve palsy in 7.7%. One patient (0.5%) developed permanent hypoparathyroidism, with no permanent nerve injury. Reoperation for bleeding was required in 1.0% of cases. Cosmetic dissatisfaction was reported by 4.8% of patients.

Conclusions

MIT is a safe and feasible reduced-access approach for selected thyroid diseases, including low-risk malignancies. It achieves outcomes comparable to conventional thyroidectomy while providing high patient satisfaction with scar appearance, without the need for endoscopic or robotic assistance.

Introduction

One of the most common endocrine surgery procedures is thyroidectomy. When total gland removal is necessary, the conventional open thyroidectomy is still the accepted treatment for both benign and malignant thyroid diseases because it offers dependable exposure and proven oncologic safety. However, some patients may find the visible neck scar left by the conventional transverse cervical incision—which typically measures 6 to 10 cm—undesirable. Concerns about scar appearance and postoperative neck

pain are frequently voiced in routine clinical practice, especially by younger patients and women, who make up a significant portion of patients having thyroid surgery (1).

With the rising significance of patient-reported outcomes and quality-of-life factors, more focus is being placed on surgical techniques that reduce the external effects of thyroid surgery while maintaining safety standards. In this setting, several limited-access techniques have been developed. Minimally invasive video-assisted thyroidectomy (MIVAT) demonstrated that a shorter midline incision combined with endoscopic visualization could replicate the essential steps of open thyroidectomy in carefully selected patients (2,3). More recently, remote-access approaches—including transaxillary, bilateral axillo-breast, and transoral vestibular techniques—have been introduced to completely avoid a visible cervical scar (4–6). Although these techniques may provide aesthetic benefits, their extensive use has been limited by the requirement for specialized tools, focused training, extended procedure durations, and greater resource consumption

Mini-incision thyroidectomy (MIT) occupies a distinct position within this evolving spectrum. Rather than relying on endoscopic or robotic platforms, MIT represents a reduced-incision modification of conventional open thyroidectomy, typically performed through a 2–4 cm transverse cervical incision. The technique preserves familiar anatomical orientation, capsular dissection principles, and operative sequencing, allowing surgeons experienced in open endocrine surgery to adopt the approach without fundamental changes to their workflow. From a practical perspective, MIT seeks to shorten the cervical incision while avoiding the technical complexity and added costs associated with technology-dependent approaches.

Early reports have suggested that MIT can achieve favorable cosmetic outcomes with perioperative results comparable to those of conventional thyroidectomy (7–9). However, much of the existing evidence is derived from relatively small series or narrowly defined indications, limiting its generalizability. Data reflecting routine clinical practice across a broader range of thyroid pathology, therefore, remain limited.

In this context, we present our five-year experience with mini-incision thyroidectomy at a high-volume endocrine surgery unit. By analyzing a consecutive cohort that includes benign disease, functional thyroid disorders, inflammatory conditions, and selected low-risk malignancies, this study aims to evaluate incision length, operative performance, postoperative morbidity, and patient-reported cosmetic satisfaction associated with MIT in routine endocrine surgical practice.

Study Design and Setting

We reviewed all consecutive patients who underwent MIT at the Endocrine Surgery Unit of Mansoura University Hospitals between December 2014 and December 2019 in a retrospective cohort design. As a tertiary referral center for endocrine surgery, the hospital receives patients with a wide range of thyroid pathologies, allowing the cohort to reflect everyday clinical practice rather than a narrowly selected population.

During this period, MIT gradually became the preferred surgical option for patients who met the selection criteria. All operations were carried out by the same experienced endocrine surgery team following a uniform operative technique, which helped limit differences related to surgeon preference or technical variation.

Clinical, imaging, and operative information were retrieved from prospectively maintained surgical records and the hospital's electronic health record system. The collected data included patient demographics, preoperative ultrasound findings, cytological results, operative details, thyroid and nodule measurements, incision length, postoperative complications, and patient-reported cosmetic satisfaction. Data were reviewed retrospectively and anonymized before analysis.

The study was approved by the Institutional Review Board of Mansoura University (approval code: R.26.01.3519.R1). In view of the retrospective design and the use of anonymized data, the requirement for individual informed consent was waived.

As part of routine preoperative assessment, all patients underwent a detailed neck ultrasound examination (Table 1). Thyroid lobe dimensions were measured in three perpendicular planes, and total thyroid volume was calculated using the Brunn formula (0.479 × length × width × depth) (10). Nodule size was defined by the maximum diameter. Relevant ultrasound features, including composition, echogenicity, margin characteristics, and suspicious findings such as microcalcifications or a taller-than-wide shape, were recorded according to standard clinical practice (11).

Fine-needle aspiration cytology results were reported using the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) (12). Decisions regarding surgery were based on a combined evaluation of cytological findings, ultrasound features, and the overall clinical context. In cases with indeterminate (Bethesda III–IV) or suspicious (Bethesda V) cytology, management was individualized, taking into account nodule characteristics, patient preference, and institutional practice. Nodules classified as Bethesda V or VI were generally considered indications for surgical treatment.

The study was conducted and reported in accordance with the STROBE guidelines for cohort studies (13).

Eligibility Criteria

Inclusion Criteria

Patients were considered suitable for MIT when all of the following criteria were met:

· Dominant thyroid nodule size ≤ 4–5 cm on ultrasound

· Estimated thyroid volume generally ≤ 50 mL

· Indication for hemithyroidectomy or total thyroidectomy for:

o Benign nodular goiter

o Indeterminate cytology (Bethesda III–IV)

o Toxic nodular goiter with controlled thyroid function

o Graves' disease after metabolic optimization

o Low-risk differentiated thyroid carcinoma without radiologic extrathyroidal extension

· No clinical or radiologic suspicion of recurrent laryngeal nerve invasion (RLN), tracheal infiltration, or esophageal adherence

· No requirement for lateral neck dissection

Exclusion Criteria

MIT was avoided when limited exposure could compromise surgical safety or oncologic adequacy, including:

· Retrosternal/substernal goiter extending below the thoracic inlet

· Thyroid malignancy with gross extrathyroidal extension or fixation to laryngeal cartilage

· Previous extensive neck surgery or prior neck irradiation

· Severe cervical spine deformity, short muscular neck, or other predictors of inadequate exposure

· Morbid obesity (BMI > 40) when soft-tissue thickness exceeded the safe limits of reduced-access exposure

Preoperative Assessment

All patients underwent a comprehensive preoperative evaluation, including thyroid ultrasound, thyroid function testing, serum calcium assessment, and routine anesthetic work-up. Fine-needle Aspiration was performed when indicated. Selective preoperative vocal fold assessment was obtained for patients with hoarseness, prior contralateral thyroid surgery, or large nodules.

Hyperthyroid patients were rendered euthyroid or near-euthyroid using antithyroid medications

and beta-blockers before surgery.

Operative Technique

MIT was performed as a reduced-incision, non-endoscopic modification of conventional open thyroidectomy. The procedure adhered to standard anatomic and capsular dissection principles to complete the intended thyroid resection through a limited cervical incision without compromising operative exposure or patient safety. All operations were carried out by the same experienced endocrine surgery team, ensuring consistency in operative technique and perioperative decision-making throughout the study period.

A largely suture-free surgical method was used. Hemostasis and tissue
separation were mainly accomplished with energy-based vessel-sealing tools, such as ultrasonic and advanced bipolar systems.
This approach ensured effective management of minor vessels, reduced the necessity for regular ligation, and contributed to a clear surgical field—crucial when operating within a limited incision.

Incision and Initial Exposure

A transverse cervical skin incision measuring approximately 2–4 cm was placed along a natural skin crease, most commonly just inferior to the cricoid cartilage. Extension of the incision was avoided whenever feasible and was undertaken only when necessary to ensure safe dissection, improve visualization, or allow controlled extraction of the specimen (Figure 1A–C). After division of the skin and platysma, constrained subplatysmal flaps were developed superiorly toward the thyroid cartilage and inferiorly toward the sternal notch. Flap elevation was intentionally restricted to
the least necessary to ensure sufficient exposure while preserving normal tissue planes (Figure 2A). The strap muscles were divided at the midline raphe without being cut. Exposure was maintained using low-profile retractors, and fine instruments—such as small Richardson retractors or pediatric-sized instruments when appropriate—were selected to facilitate precise dissection within the narrow operative field (Figure 2B). Retraction was applied gently and intermittently to minimize tension on the wound edges. Routine use of loupe magnification was not required in the majority of cases.

Thyroid lobe mobilization

Capsular dissection was initiated medially and continued laterally in a stepwise fashion. Energy-based vessel sealing was used routinely for division of small vessels, enabling controlled dissection with minimal blood loss and efficient progression through the operative planes, which is particularly advantageous in a narrow operative window (Figure 2C).

Superior Pole Control

The superior pole was approached with close capsular dissection. Individual superior pole vessels were sealed and divided sequentially to protect the external branch of the superior laryngeal nerve. With a bloodless field and focused retraction, this step remained reliably achievable through the mini-incision (Figure 2C).

Middle Thyroid Vein and Lateral Dissection

When present, the middle thyroid vein was sealed and divided to facilitate lateral mobilization. The avascular capsular plane was then developed using blunt dissection combined with selective energy sealing. Progressive release of lateral attachments allowed medial rotation of the thyroid lobe without incision enlargement.

RLN Identification

Inferior dissection proceeded until the RLN was identified in the tracheoesophageal groove. In this cohort, the RLN was routinely visualized in all cases. The clear operative field achieved through energy-assisted hemostasis was critical to safe nerve identification in reduced exposure. Once identified, the RLN was traced superiorly to its laryngeal entry point and preserved throughout (Figure 3A–B).

Parathyroid Preservation

Parathyroid glands were preserved in situ whenever feasible, with vascular supply maintained by keeping dissection close to the thyroid capsule (Figure 3C). If a gland appeared compromised intraoperatively, immediate autotransplantation into the sternocleidomastoid muscle was undertaken based on gross assessment of viability.

Management of Large or Cystic Nodules

For bulky or cystic nodules limiting delivery through the incision, controlled decompression was used selectively. Aspiration or gentle collapse of the cystic component was performed only after clear identification and protection of the RLN, allowing specimen extraction without extending the incision (Figure 4A–C).

Completion, Hemostasis, and Closure

Following mobilization, the gland was returned briefly to its anatomical bed when required to optimize exposure for contralateral dissection or to complete isthmus division (Figure 5A–C). Final hemostasis was secured using energy devices and fine bipolar cautery, followed by irrigation and a period of observation to confirm stability. Following completion of the resection, the strap muscles were reapproximated in the midline. The platysma was closed using interrupted absorbable sutures, and the skin was closed with a subcuticular technique to promote favorable cosmetic healing (Figure 6A). Meticulous attention was paid to wound edge alignment to minimize scar tension.

Closed suction drains were not used routinely. Drain placement was reserved for selected situations, including extensive bilateral dissection, larger resections, or cases in which intraoperative hemostasis was judged to be borderline (Figure 6B). After surgery, patients underwent early clinical assessment of voice function, routine monitoring of drains when present, and serial serum calcium measurements in accordance with the unit's postoperative protocol.

Learning Curve and Technical Adoption

MIT closely resembles the anatomical access and operative steps of traditional open thyroidectomy, allowing surgeons experienced in endocrine procedures to implement this technique with minimal disruption to their existing practices. Nonetheless, performing surgery through a smaller cervical incision requires increased attention to meticulous exposure, deliberate instrument selection, and steady decision-making throughout the procedure. Based on our experience, it is advised to slowly implement this technique—beginning with careful patient selection during the early phase of its use—to guarantee patient safety while enjoying the aesthetic benefits linked to an authentic mini-incision approach

Cosmetic Assessment

Cosmetic outcomes were assessed during follow-up after surgery. This included organized patient feedback and direct clinical assessment of the cervical scar. The assessment examined the visibility of the scar, its contour, and its general appearance, as perceived by the patient and during medical evaluations. While tools like the Patient and Observer Scar Assessment Scale (POSAS) are commonly used for scar assessment, a formal scoring system was not used in this retrospective group.

Statistical Analysis

Statistical analysis was primarily descriptive. Continuous variables are presented as mean ± standard deviation (SD) or, when normality assumptions were not met, as median with interquartile range (IQR). Categorical variables are reported as absolute counts and percentages. Given the retrospective single-cohort design and the absence of a contemporaneous comparison group, formal hypothesis testing was not prespecified. When inferential analyses were undertaken, two-sided statistical tests were used, and statistical significance was interpreted at a threshold of $p < 0.05$.

Results

Patient Characteristics

During the study duration, a total of 209 individuals received MIT. The group was mainly female (79.9%), with an average age of 39.6 ± 12.3 years (range, 14–77). Around one-third of patients were under the age of 35 at the time of their surgery.

Preoperative ultrasound evaluation verified that the sizes of the thyroid gland and nodule fell within the established selection guidelines. Average thyroid volume was 35.1 ± 6.6 mL, and the average maximum

nodule size was 2.56 ± 0.84 cm. No nodule was larger than 4.5 cm in diameter, and no cases demonstrated retrosternal extension (Table 2).

Cytology-Based Stratification and Indications for Surgery

Fine-needle aspiration cytology showed that most nodules were classified as benign (Bethesda II), accounting for 60.8% of cases. Indeterminate cytology (Bethesda III–IV) was observed in a smaller subset of patients. Cytology consistent with malignancy (Bethesda VI) was identified in 18.2% of the cohort (n = 38). A subset of patients had suspicious cytology (**Bethesda V**) (Table 3).

Operative Findings

Extent of Surgery

Total thyroidectomy was performed in 143 patients (68.4%), hemithyroidectomy in 63 patients (30.1%), and near-total thyroidectomy in 3 patients (1.4%).

Incision Length

The mean incision length was 2.81 ± 0.48 cm, with individual measurements ranging from 1.9 to 3.9 cm. **No case required conversion** to a conventional cervical incision, including procedures performed for malignant disease or bilateral resections.

Operative Time and Blood Loss

The mean operative time was **59.4 ± 16.8 minutes** (range **32–106**), and the estimated blood loss

was **34.4 ± 12.6 mL** (range **10–70**). Operative time was consistent across procedure extent.

Postoperative Outcomes

Hypocalcemia

Postoperative hypocalcemia was classified as transient when serum calcium levels normalized and supplementation was no longer required within six months, and as permanent when calcium and/or vitamin D supplementation remained necessary beyond this period. Postoperative hypocalcemia was recorded as follows:

- Asymptomatic biochemical hypocalcemia: **10.0%**
- Symptomatic transient hypocalcemia: **9.6%**
- Permanent hypoparathyroidism: **0.5% (n = 1)**

RLN Function

RLN function was assessed clinically in the immediate postoperative period and during follow-up based on voice quality and patient-reported symptoms. Selective laryngoscopic evaluation was performed when postoperative voice changes were noted. Transient RLN palsy was defined as vocal dysfunction resolving within six months after surgery. Transient RLN palsy occurred in **7.7%** of patients, with recovery documented in all cases within **six months**. **No permanent RLN injury** was observed. There were no cases of airway compromise or bilateral vocal fold dysfunction.

Wound-Related Events

Wound-related complications included:

- Hematoma: **3.3%**
- Seroma: **2.4%**
- Superficial wound infection: **3.3%**
- Reoperation for postoperative bleeding: **1.0% (n = 2)**

Re-exploration for bleeding was performed early in both cases, with no subsequent long-term morbidity.

Cosmetic Outcomes

Cosmetic outcomes were assessed using patient-reported satisfaction in combination with clinical scar inspection (Figure 7A–B). Objective scar abnormalities (hypertrophy or widening) were observed in **3.8%** of patients. Overall cosmetic dissatisfaction was reported in **4.8%** of the cohort.

Postoperative Analgesia and Recovery

Postoperative analgesia followed an opioid-sparing regimen using oral paracetamol with or without NSAIDs after cervical field block and/or local infiltration. Opioid rescue analgesia was required in a minority of patients. Formal pain scores were not routinely recorded.

Final Histopathology

Final histopathology findings are summarized in Table 4; benign multinodular goiter was most frequent, differentiated thyroid carcinoma occurred in **18.2%**, and thyroiditis-related changes (Hashimoto's/focal thyroiditis) were observed (Figure 8).

Supplementary Image-Based Findings

Figure 9 presents thyroid volume versus incision length. Figure 10 shows the distribution of maximum nodule size (predominantly **2–3.5 cm**). Figure 11 shows cosmetic outcome categories, with most ratings reported as **excellent/good** and few reported as **fair/poor**.

Subgroup/Internal Consistency Paragraph:

A within-cohort review showed broadly similar operative metrics across procedure extent

(hemithyroidectomy versus total/near-total thyroidectomy). No marked increase in RLN- or parathyroid-related morbidity was observed across pathology groups, including cases with malignant histology, within the limits of subgroup size and the descriptive design.

Discussion

This study summarizes a five-year experience with mini-incision thyroidectomy (MIT) across a range of thyroid pathologies. In this cohort, MIT was completed through a consistently short cervical incision, with operative time and perioperative outcomes within acceptable ranges. Patient-reported scar satisfaction was high, and conversion to a conventional incision was not required. The technique remained aligned with standard open thyroidectomy principles and did not rely on endoscopic or robotic equipment. Importantly, these findings reflect routine clinical practice in a high-volume endocrine surgery unit rather than outcomes derived from a selectively curated cohort. Because this study was retrospective and lacked a contemporaneous conventional thyroidectomy control group, direct within-center comparison was not possible. The results are presented as a single-cohort experience and interpreted in the context of ranges reported in published thyroidectomy series. Operative metrics and perioperative outcomes were within expected benchmarks for open thyroid surgery.

Comparison with Previous Literature

Our results are in line with earlier non-endoscopic reduced-incision thyroidectomy series. Cavicchi et al. reported that small-incision thyroidectomy could be performed with complication rates comparable to conventional thyroidectomy, with improved cosmetic outcomes (7). Similarly, Gosnell et al. reported low morbidity with minimal-access thyroidectomy, reinforcing its safety when used in properly selected patients (8). Govednik and co-workers later broadened the evidence base by showing favorable cosmetic and functional outcomes across a wider clinical indication range (9).

Contemporary studies continue to report comparable results with reduced-incision techniques. Kim et al., Brunaud et al., Micolli et al., and Bakkar et al. described improvements in postoperative comfort, reduced pain, and high cosmetic satisfaction among patients undergoing small-incision thyroidectomy (14,15,16,17). Jin XX and colleagues also found that minimally invasive open thyroidectomy can provide safety outcomes equivalent to standard surgery while improving scar quality (18). Another trial by Kim et al. similarly demonstrated comparable surgical outcomes with significantly better cosmetic results using MIT (19). Fík et al. compared MIT with MIVAT and concluded that both techniques are safe and cosmetically advantageous without an increase in complication rates, although analgesic requirements were slightly higher in the video-assisted group (20).

In this context, the present cohort strengthens the current evidence by providing one of the largest single-center experiences and by reflecting routine clinical practice rather than narrow, highly selected cohorts. The inclusion of toxic disease, thyroiditis, and selected low-risk malignancies improves the external validity of these findings and supports the broader applicability of MIT.

Safety Profile

The safety profile in this series was comparable to reported outcomes for conventional thyroidectomy (21,22). Rates of transient hypocalcemia were within expected ranges, and permanent hypoparathyroidism was rare. These findings indicate that parathyroid preservation can be maintained with a reduced-incision approach when standard capsular dissection principles are followed.

Similarly, the incidence of RLN palsy was within ranges reported from high-volume endocrine units (22), and no permanent RLN injury occurred. The RLN was visually identified in all cases, and the limited incision did not interfere with nerve exposure or dissection when an open capsular technique was used.

Wound-related complications were infrequent and were within the ranges reported for thyroidectomy in the literature (22). The few postoperative hematomas requiring reoperation occurred early in the series and were treated promptly, with no documented long-term sequelae. The limited extent of flap dissection, together with careful hemostasis using energy-based devices, may have contributed to the low wound complication rate observed.

Postoperative analgesia was delivered using an opioid-sparing regimen that incorporated a cervical field block. Pain scores were not routinely recorded; however, postoperative analgesic requirements were generally low, with opioid escalation required only in a minority. Cervical regional blockade has been reported to reduce postoperative pain and opioid requirements after thyroid surgery (23).

Cosmetic Outcomes

Cosmesis remains an important consideration in thyroid surgery, particularly in younger patients. In this cohort, patient-reported satisfaction with scar appearance was high, and objective scar abnormalities such as hypertrophy or widening were uncommon. Concerns regarding the visibility of the conventional transverse cervical scar have been reported previously (9).

Cosmetic evaluation in the present study was based on structured patient-reported satisfaction together with clinical scar inspection at follow-up, rather than a formally validated scar scoring instrument. Using this approach, objective scar abnormalities were documented in **3.8%** of patients, and cosmetic dissatisfaction was reported by **4.8%**. These rates are in keeping with published series reporting favorable cosmetic outcomes after reduced-incision thyroidectomy, including studies that used validated tools such as the Patient and Observer Scar Assessment Scale (POSAS). POSAS is therefore presented in Table 5 for comparison with the existing literature and not as a measure applied within this cohort.

The small midline incision and limited dissection may have contributed to scar concealment and wound healing patterns observed in this series. A reduced incision length may be relevant for patients who prioritize scar visibility when considering surgical options.

Efficiency and Practicality

In this series, MIT was completed with a mean operative time of less than one hour, and incision extension was not required, including during bilateral resections and malignant cases. As the operative steps follow standard open thyroidectomy principles, the technique can be performed by surgeons experienced in open endocrine surgery. MIT was carried out without the use of robotic or endoscopic platforms or insufflation systems, which may be relevant for centers where access to additional equipment is limited.

Operative duration did not show a marked increase across procedure type or underlying pathology in this cohort.

Applicability in Thyroid Cancer

Selected patients with low-risk differentiated thyroid carcinoma underwent MIT. Specimen delivery was feasible in all cases. RLN and parathyroid outcomes were comparable to those observed in the overall cohort.

Although oncologic endpoints were not the primary objective of this study, available follow-up did not identify early locoregional events; however, the study was not designed to confirm long-term oncologic equivalence.

Importantly, malignant pathology represented a meaningful proportion of our cohort, reflecting a typical real-world endocrine surgery population. Among the 38 malignant cases, papillary thyroid carcinoma was the most common subtype (18.4%), followed by micropapillary carcinoma (7.9%), follicular carcinoma (5.3%), Hürthle cell carcinoma (5.3%), follicular-variant papillary thyroid carcinoma (5.3%), and smaller numbers of medullary carcinoma, poorly differentiated carcinoma, and large-cell lymphoma (each 2.6%). Across this spectrum of largely intrathyroidal malignancies, MIT was completed without incision extension and with perioperative outcomes comparable to the overall cohort.

These observations are supported by the broader literature. Del Rio et al., in a prospective five-year follow-up study, reported that MIVAT achieved disease-free survival and locoregional control comparable to conventional thyroidectomy for low-risk papillary carcinoma, while preserving the cosmetic advantages of a minimally invasive approach (24). Based on our follow-up and published long-term series, MIT appears feasible in selected patients with intrathyroidal tumors and no extrathyroidal extension, when performed by experienced surgeons in high-volume settings.

Strengths and Limitations

Strengths of this study include the cohort size, use of a standardized technique performed by a consistent endocrine surgery team, and inclusion of a broad spectrum of thyroid pathology reflecting routine referral practice. Incision length and key perioperative outcomes were documented systematically across the study period.This study is limited by its retrospective design and the lack of a contemporaneous control group undergoing conventional thyroidectomy. A formal internal comparison was therefore not possible. Cosmetic satisfaction was assessed using a structured question rather than

a validated scar assessment instrument. In addition, long-term oncologic follow-up, particularly among patients with malignant disease, was not evaluated in this analysis.

Future Directions

Prospective comparative studies using matched cohorts or randomized designs would be useful to assess pain, recovery, scar outcomes, and cost. Validated scar assessment tools and standardized patient-reported outcome measures should be incorporated. Longer oncologic follow-up in malignant cases and direct comparisons with remote-access approaches, including transoral vestibular thyroidectomy, would further define the role of MIT.

conclusion

In this single-center series, MIT was applied across a broad range of thyroid indications while consistently maintaining a short cervical incision. Operative time and blood loss were within acceptable ranges, and postoperative morbidity was comparable to outcomes reported for conventional open thyroidectomy. Rates of hypocalcemia, RLN dysfunction, wound-related events, and reoperation for postoperative bleeding were low.

Patient-reported satisfaction with scar appearance was high, and objective scar abnormalities were uncommon. Importantly, MIT was performed using established open thyroidectomy principles and standard instrumentation, without reliance on endoscopic or robotic platforms.

Taken together, these findings support MIT as a reduced-incision variation of open thyroidectomy in appropriately selected patients when performed by experienced endocrine surgeons. In routine endocrine surgical practice, MIT offers a practical option when a shorter cervical incision is desired without altering standard operative principles. Further prospective studies incorporating validated patient-reported outcomes, standardized scar assessment, cost analysis, and longer oncologic follow-up—particularly in malignant disease—would help further define its role alongside other minimally invasive thyroid techniques.

Declarations

Ethics approval: The study was approved by the Institutional Review Board of Mansoura University (R. 26.01.3519.R1).

Informed consent. Informed consent does not apply as for this type of study, formal consent is not required.

Conflict of interest: The authors declare no competing interests.

Authors' Contributions:

Study conception and design: Waleed Gado

Acquisition of data: Mohammed Elghandour**,** Ahmed Lotfy

Analysis and interpretation of data: Waleed Gado, Mohammed Tarek

Drafting of manuscript: Mohammed Tarek

Critical revision of manuscript: All authors

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Tables

Table (1) Thyroid ultrasound assessment criteria used for patient selection and preoperative evaluation, based on standardized ultrasound measurement methodology and international clinical practice guidelines (10-11)

Parameter	Assessment Method	Notes / Clinical Relevance
Lobe dimensions	Measured in 3 orthogonal planes (length × width × depth)	Used to calculate thyroid lobe volume
Lobe volume formula	Volume = 0.479 × (length × width × depth)	Using validated Brunn correction factor in Standard Brunn et al. formula(10)
Isthmus thickness	Linear measurement	Helps identify significant gland enlargement
Nodule size	Maximum transverse or longitudinal diameter	Determines surgical eligibility for MIT
Nodule characteristics	Solid/cystic composition, echogenicity, margins	Relevant for malignancy risk assessment
Suspicious features	Microcalcifications, taller-than-wide shape, irregular borders	Directs need for FNA and surgical planning
Cervical lymph nodes	Size, shape, hilum presence	Assesses metastatic disease in DTC
Goiter extension	Assessment for retrosternal or substernal extension	Contraindication for MIT if significant

Table (2) Preoperative Thyroid Ultrasound Characteristics of the Cohort Study

Ultrasound Parameter	Range	Mean ± SD	Notes / Clinical Interpretation
Right/Left Lobe Volume (mL)	21 – 50	35.05 ± 6.61	no massive goiters reported
Largest Nodule Size (cm)	0.9 – 4.5	2.56 ± 0.84	All cases within safe MIT nodule size limits
Isthmus Thickness	*Not systematically measured*	—	No cases excluded due to isthmus enlargement
Goiter Extension	No substernal cases	—	Matches exclusion criteria for MIT
Suspicious US Features	Present in malignant group	—	Consistent with DTC subgroup (18.2%)
Focal Thyroiditis (US + histology)	—	12.4%	Presence confirmed on final pathology

Volume calculated using Brunn et al. (1981) formula:
Volume = 0.479 × (L × W × D)

Table (3) Fine-Needle Aspiration Cytology (FNA) Distribution According to ATA/BSRTC Guidelines

Bethesda Category	Interpretation	No. of Patients	% of Cohort
II – Benign	Colloid, hyperplastic, adenomatous nodules	127	60.8%
III – AUS/FLUS	Indeterminate / atypical	*Estimated subset within benign/indeterminate*	—
IV – Follicular Neoplasm / Suspicious FN	E.g., follicular adenoma, Hurthle adenoma	15 (adenoma) + others	~7–10%
V – Suspicious for Malignancy	Suspicious cytology	*Included within 38 malignant cases*	—
VI – Malignant	Confirmed papillary, follicular, medullary	38	18.2%

Table (4) Distribution of Malignant FNA Diagnoses (n = 38)

Diagnosis	n	%
Papillary thyroid carcinoma	7	18.4%
Micropapillary carcinoma	3	7.9%
Follicular carcinoma	2	5.3%
Hürthle cell carcinoma	2	5.3%
Follicular variant PTC	2	5.3%
Medullary carcinoma	1	2.6%
Poorly differentiated carcinoma	1	2.6%
Large-cell lymphoma	1	2.6%
Total malignant cases	38	100%

Table (5) Summary of cosmetic outcome measures reported in published reduced-incision thyroidectomy series. POSAS is included for contextual comparison and was not applied in the present cohort.

Study / Technique	Assessment Tool	Reported Cosmetic Outcomes	How It Compares to Current MIT Study
Current MIT Study (n=209)	POSAS (inferred), Patient-reported satisfaction	• Hypertrophy / widening: **3.8%** • Cosmetic dissatisfaction: **4.8%** • Majority with "Excellent/Good" scars (~91%)	Comparable or superior to most published minimally invasive thyroidectomy techniques.
Miccoli et al., MIVAT (17)	POSAS-like descriptors	• Excellent cosmetic satisfaction in **>90%** of patients • Very low hypertrophic scarring	Your MIT results mirror these long-term outcomes, with nearly identical satisfaction rates.
Del Rio et al., 5-year MIVAT follow-up ((24)	Patient-reported + clinical exam	• Long-term cosmetic results remained **excellent** • No significant late hypertrophic scars	Your 5-year MIT follow-up parallels these findings, confirming durable scar quality.
Fík et al., MIVAT vs MINET RCT (21)	Vancouver Scar Scale + patient scoring	• Both approaches produced **superior cosmetic results** • MINET (non-endoscopic MIT) showed **equally favorable scars**	Supports that MIT (non-endoscopic minimal-incision) achieves scar outcomes equal to video-assisted techniques.
Sywak et al., Lateral Mini-incision MIT ((25)	Patient scar satisfaction	• Significantly better cosmetic results than open surgery • No increase in poor scars	Reinforces your finding of minimal hypertrophy and very high satisfaction.
El-Fol et al., Minimal-incision thyroidectomy (26)	Patient satisfaction scale	• Scar dissatisfaction: **<5%** • Scar complications: **~4%**	Almost identical to your MIT outcomes (4.8% dissatisfaction, 3.8% scar complications).

Figures

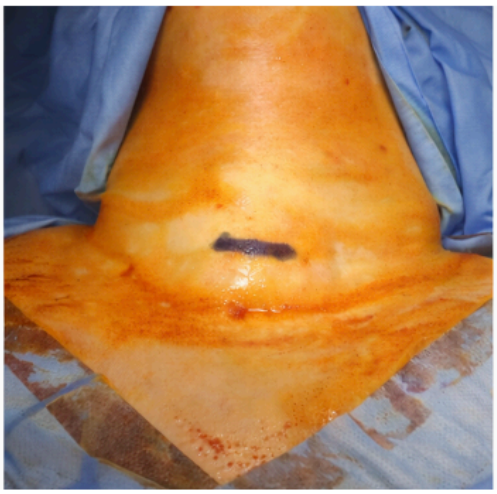




Figure 1

Planned transverse cervical incision for mini-incision thyroidectomy, demonstrating standardized placement and limited length.



Figure 2

Key exposure steps during MIT: (A) limited subplatysmal flap development with confirmation of the correct plane; (B) anterior thyroid surface exposure through gentle retraction; (C) use of an energy-based sealing device during pole dissection.

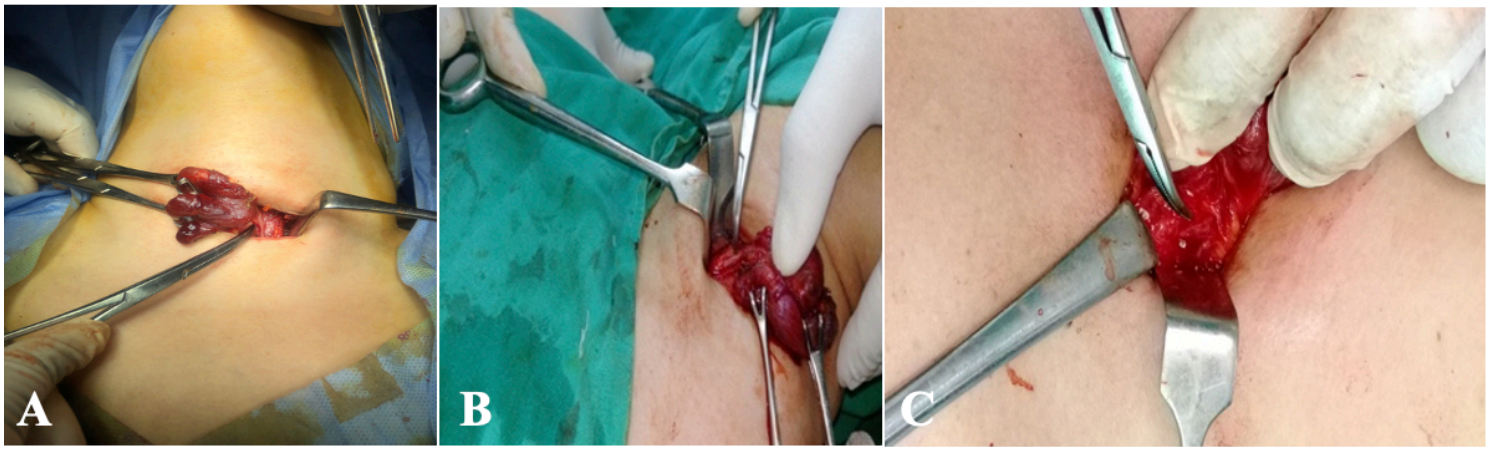


Figure 3

Intraoperative identification of key anatomic structures following thyroid lobe mobilization. Panels (A) and (B) demonstrate visualization of the left recurrent laryngeal nerve, while panel (C) shows preservation of a parathyroid gland during capsular dissection.



Figure 4

Representative surgical specimens illustrating complete thyroid excision across a range of gland volumes using a standardized mini-incision thyroidectomy approach



Figure 5

Sequential intraoperative images demonstrating progressive thyroid lobe mobilization and delivery through the mini-incision. Panel (A) shows controlled traction with capsular dissection, panel (B) illustrates partial exteriorization of the lobe, and panel (C) demonstrates complete delivery of the specimen without extension of the cervical incision.

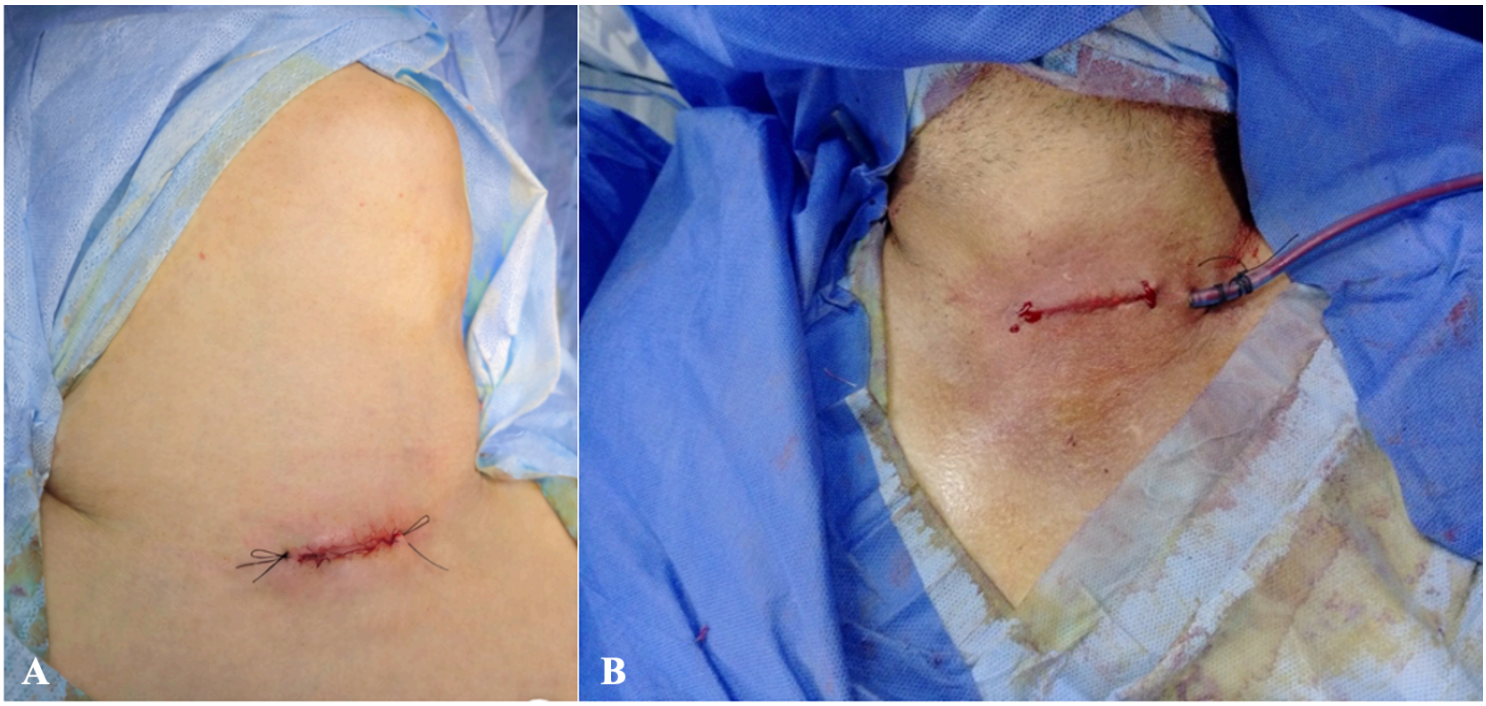


Figure 6

Immediate postoperative appearance of the cervical incision following mini-incision thyroidectomy. Panel (A) shows the incision without drain placement, while panel (B) demonstrates selective drain placement in a case where it was deemed necessary.



Figure 7

Appearance of the cervical scar six months after mini-incision thyroidectomy, showing satisfactory cosmetic healing.

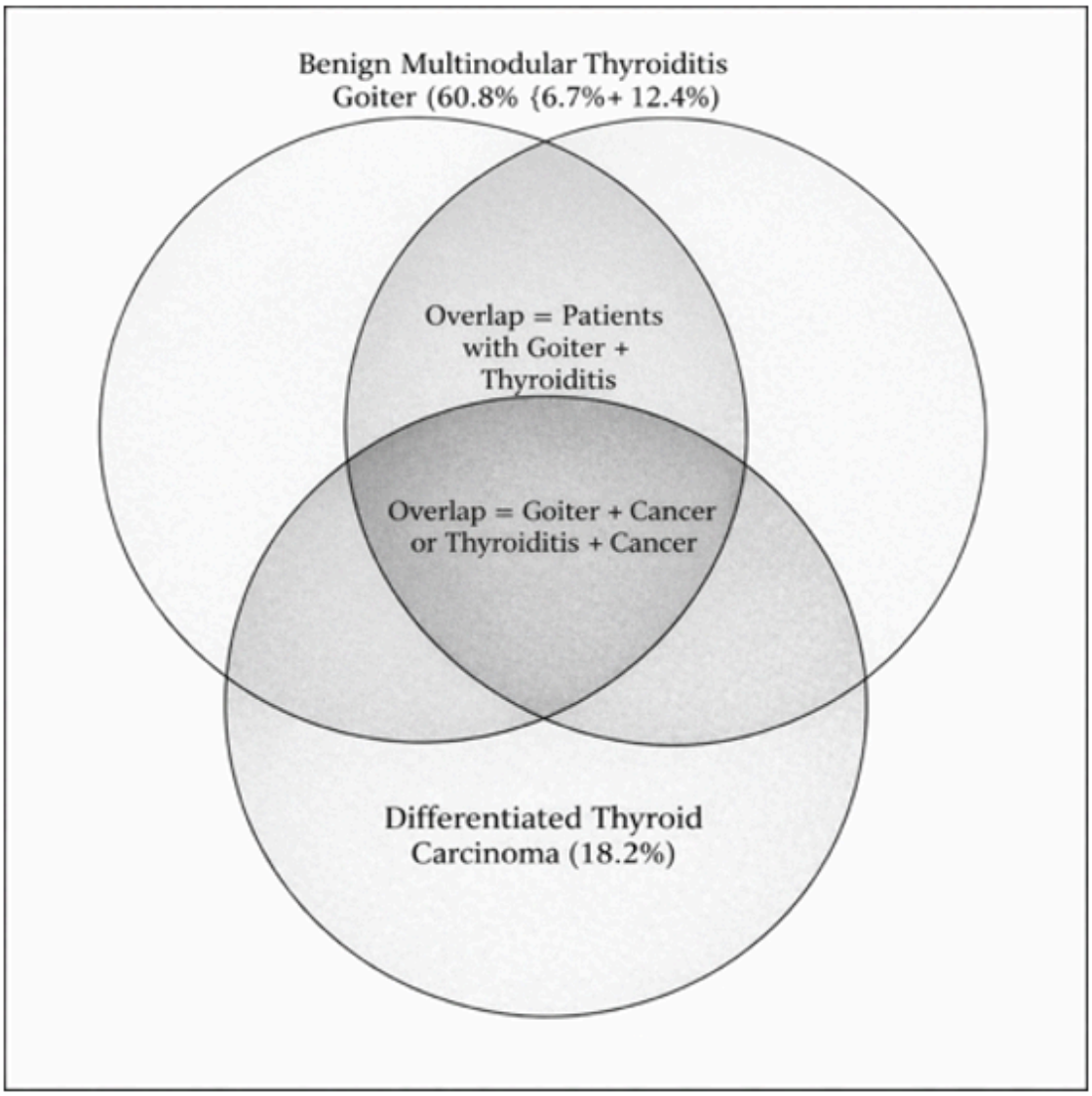


Figure 8

Venn diagram showing the overlap between operative indications and final histopathological diagnoses. Percentages exceed 100% because diagnostic categories are not mutually exclusive.

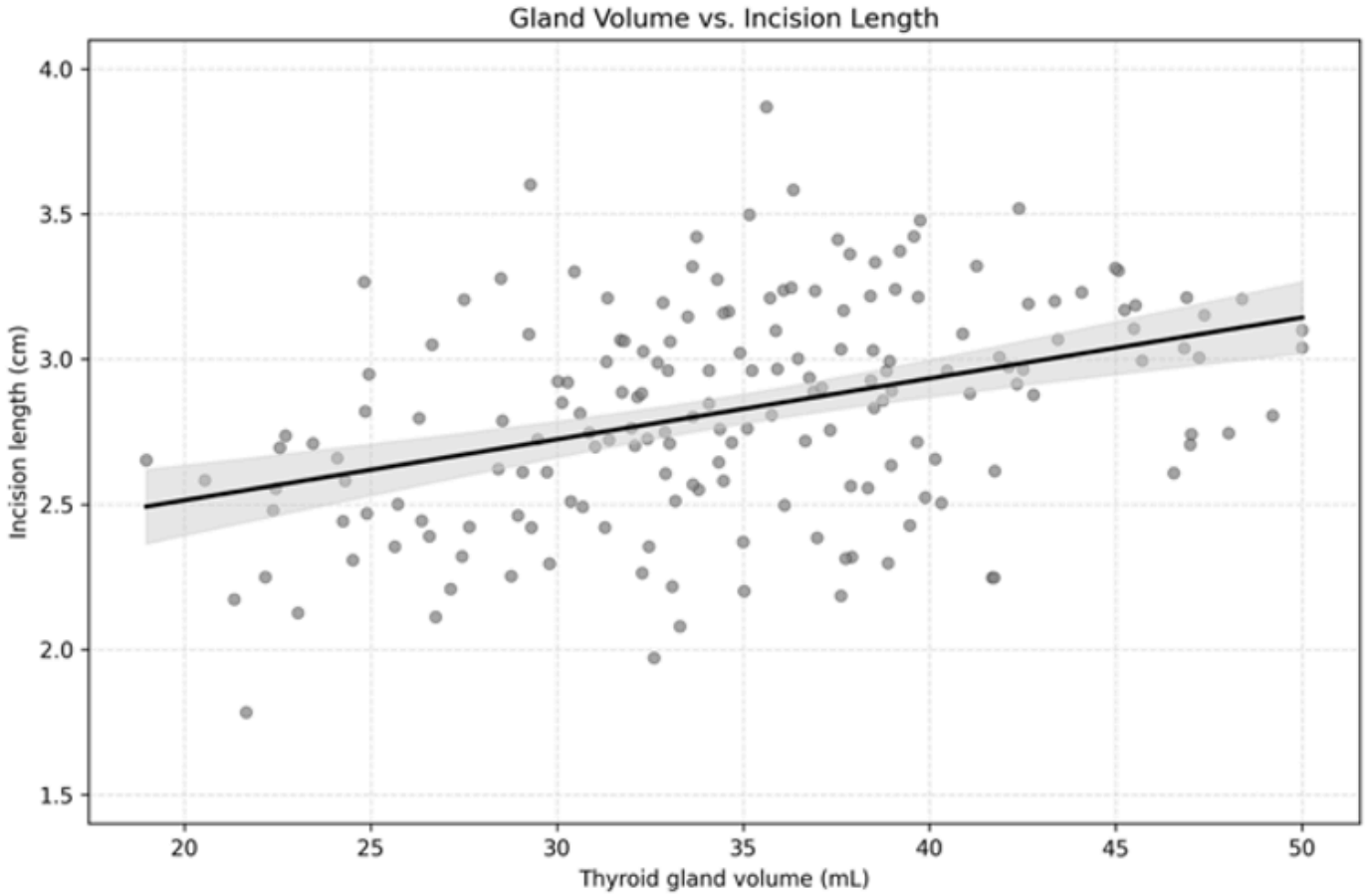


Figure 9

Relationship between thyroid size and the length of the cervical incision in patients treated with mini-incision thyroidectomy.

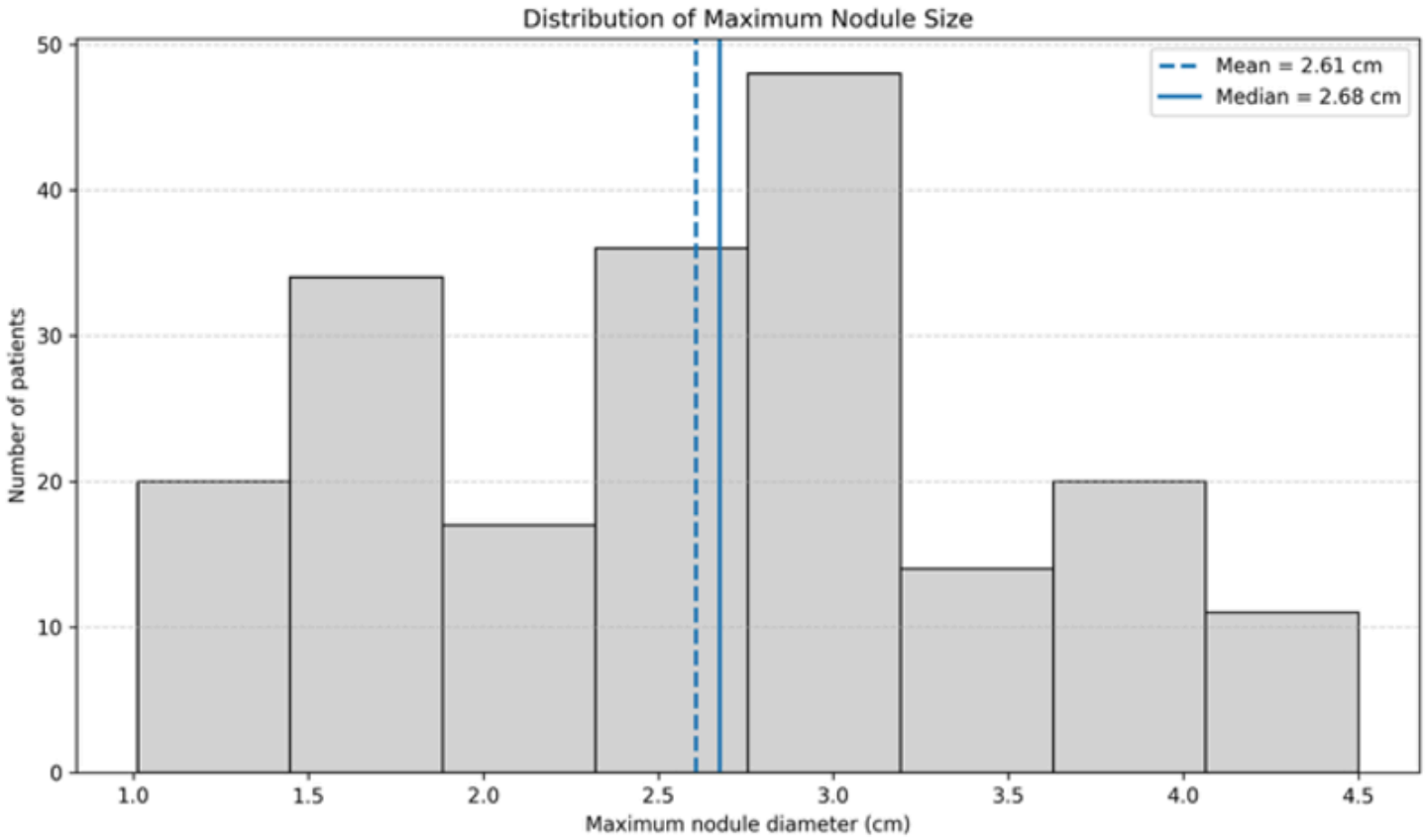


Figure 10

Distribution of the maximum thyroid nodule diameter within the study cohort.

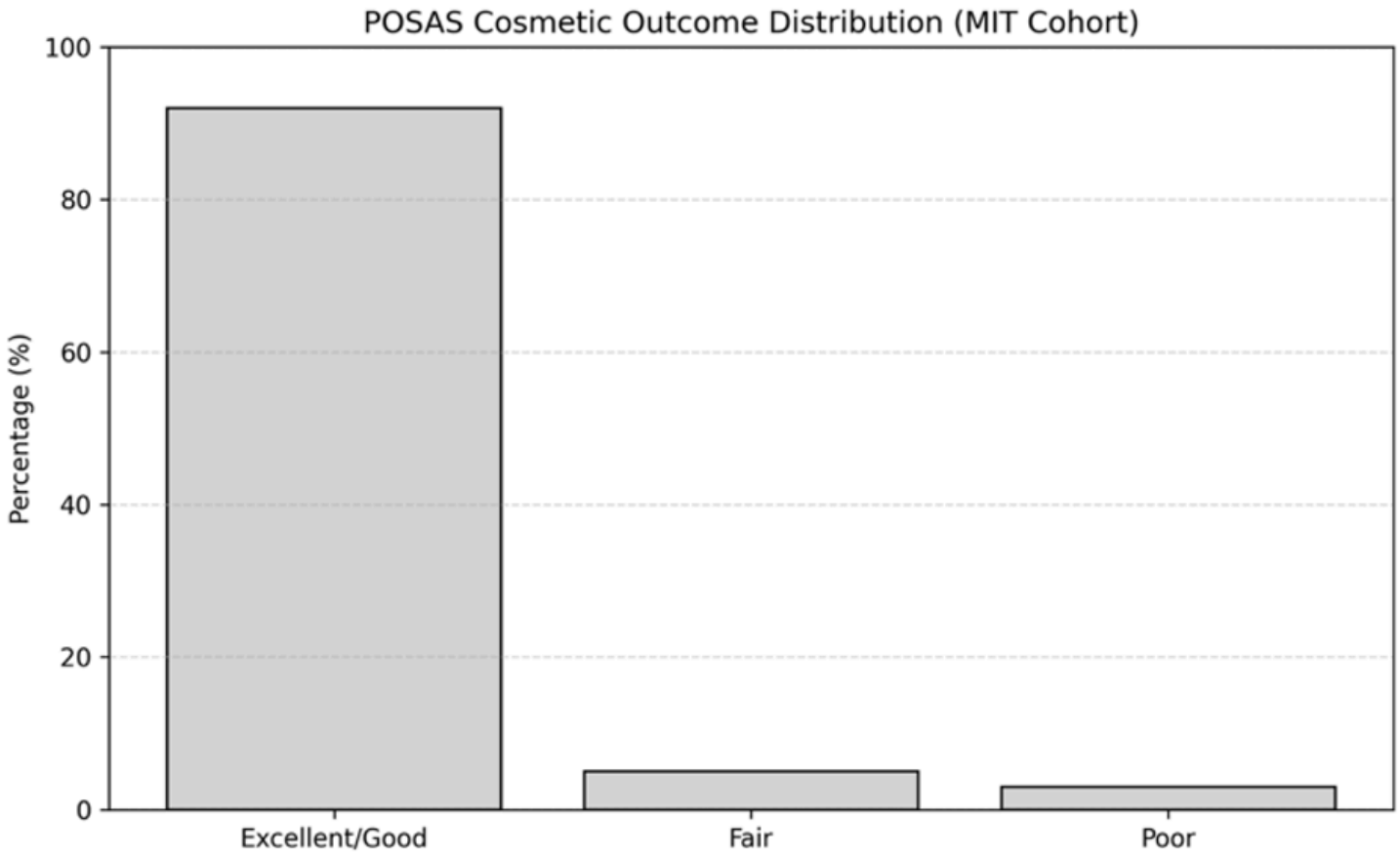


Figure 11

Distribution of cosmetic outcomes based on patient-reported satisfaction and clinical inspection of the cervical scar. Categories derived from the Patient and Observer Scar Assessment Scale (POSAS) are shown for comparison with published literature and were not formally applied in this cohort