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Safety and cosmetic results of trans-submental endoscopic thyroidectomy

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The increasing incidence of thyroid tumors, combined with patients' growing emphasis on cosmetic outcomes, has fueled advancements in endoscopic thyroidectomy techniques. This study aims to evaluate the safety, feasibility, and aesthetic outcomes of trans-submental endoscopic thyroidectomy (TSET), a novel approach designed to overcome the limitations of the oral vestibular route. Clinical data from 95 patients who underwent TSET at our institution between May 2022 and December 2024 were retrospectively analyzed. Inclusion criteria were benign thyroid nodules ≤ 4 cm or papillary thyroid carcinoma (PTC) ≤ 3 cm without lateral neck or distant metastasis. Surgical outcomes, complications, and patient satisfaction were systematically assessed. Of the 96 patients initially enrolled, one required conversion to open thyroidectomy due to intraoperative bleeding. The remaining 95 patients successfully completed TSET, including 48 unilateral partial thyroidectomies, 6 bilateral partial thyroidectomies, 38 lobectomies with unilateral central neck dissection (UCND), and 3 total thyroidectomies with UCND. The mean operative time was 158.3 ± 40.1 min. No permanent complications, such as recurrent laryngeal nerve (RLN) injury or hypoparathyroidism, were observed. Transient RLN palsy occurred in 2 patients and resolved with conservative management. Aesthetic outcomes were highly satisfactory, with hidden submental scars and no postoperative infections reported. During the follow-up period (mean: 14.0 ± 7.7 months), no tumor recurrence was observed. TSET is a safe and feasible surgical approach with good cosmetic results and shows promising development prospects.

Keywords Endoscopic thyroidectomy, Submental, Safety, Cosmetic results

Over the past few decades, the incidence of benign and malignant thyroid tumors has been continuously rising worldwide, with particularly notable increases among women and younger populations[1–3]. Papillary thyroid carcinoma (PTC) is the most common malignant thyroid tumor, and the majority of cases can achieve clinical cure through surgery. Due to the low mortality and recurrence rates of thyroid diseases, as well as the increasing emphasis on aesthetic appearance among patients, surgeons are paying more attention to treatment methods that achieve better cosmetic outcomes.

Compared with conventional open thyroidectomy (OT), endoscopic thyroidectomy demonstrates significant aesthetic advantages by avoiding neck incision scars[4–6]. This advantage has driven the development of various endoscopic thyroidectomy approaches, including oral[7–9], axillary[10–12], breast[13], and hybrid oral-submental approaches[14]. Among these, the oral approach has been widely adopted due to its superior aesthetic outcomes, scientifically designed surgical pathway, and excellent bilateral thyroid exposure[15–17]. However, this technique has notable drawbacks. Firstly, the incidence of mental nerve injury with oral vestibular incisions ranges from 12 to 25%, potentially causing varying degrees of numbness around the chin[18,19]. Secondly, creating the surgical space requires dissection of the anterior chin area, separating soft tissue from bone, which poses a significant challenge in tunnel dissection[20,21]. Additionally, the oral approach is classified as a Class II incision, which may increase the risk of infection.

To address the aforementioned issues with the oral approach, we designed the submental approach, relocating the incision site from the oral vestibule to the submental region. Its main advantage lies in retaining the benefits

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of the oral approach while avoiding mental nerve injury, the high anatomical difficulty, and the infection risk associated with the Class II incision of the transoral route. In terms of aesthetic outcomes, although the submental incision cannot achieve the scar-free surface effect of the oral approach, the low skin tension in the submental region results in minimal scarring from the approximately 1 cm incision. Furthermore, the hidden location of the submental incision ensures that the submental approach can achieve the desired cosmetic results[22–24].

Therefore, we began performing trans-submental endoscopic thyroidectomy (TSET) in May 2022. As of December 2024, we have successfully performed TSET on 95 patients, some of whom have completed follow-up for up to 30 months. This study aims to share our experience and evaluate the safety, feasibility, and aesthetic outcomes of TSET.

Methods

Patient selection

We retrospectively analyzed the clinical data of 95 patients who underwent TSET in the Thyroid Surgery Department of our hospital between May 2022 and December 2024. Inclusion criteria included[1]: thyroid benign nodules assessed by preoperative ultrasound with a diameter not exceeding 4 cm[2]; PTC confirmed by preoperative fine-needle aspiration biopsy with a diameter not exceeding 3 cm[3]; no lateral neck lymph node or distant metastasis[4]; clear aesthetic demands from the patient. Exclusion criteria were[1]: suspected invasion of the trachea, esophagus, or recurrent laryngeal nerve by the primary tumor[2]; a history of prior neck surgery or radiotherapy[3]; intraoperative conversion to open surgery. This study was approved by the Medical Ethics Committee of our hospital (Approval Number: 2022004). Our hospital offers both OT and TSET, and patients chose their surgical method based on personal preference after being fully informed of the risks and benefits of both techniques. All surgeries were performed in strict adherence to the "Guidelines for the Diagnosis and Treatment of Thyroid Nodules and Differentiated Thyroid Cancer" and were conducted by the same surgeon. All patients provided written informed consent before surgery.

Surgical technique

The surgical procedure consists of three steps: first, preoperative surface marking; second, creation of the surgical workspace; third, completion of thyroidectomy and central lymph node dissection. Before anesthesia, the optimal surgical incision sites were marked in the standing position based on the natural neck skin texture of the patient (Fig. 1). The central submental incision was located between the chin and the hyoid bone, at least two finger-widths below the chin, with a length of approximately 1.0 cm. The incisions on both sides of the neck were approximately 0.5 cm in length.

General anesthesia was then administered, followed by orotracheal intubation. A customized 7.5 cm-long endoscopic sheath was used during the procedure. Three transverse incisions were made at the pre-marked sites, and the initial surgical channels were created through blunt dissection. A 1.0 cm trocar was inserted through the submental incision, and two 0.5 cm trocars were inserted through the mandibular incisions on either side (Fig. 2). A standard 10-mm diameter, 30° angled endoscope was used in conjunction with operative and auxiliary rods to perform the procedure. Carbon dioxide gas was insufflated at a pressure of 6 mmHg and a flow rate of 14 L/min to expand the surgical tunnel. The surgical tunnel extended inferiorly to the sternal notch and laterally to the sternocleidomastoid muscle. At this point, the creation of the operative workspace was complete (Fig. 3).

Thyroidectomy and central neck dissection (CND) were performed according to standard surgical procedures. During the procedure, meticulous dissection along the thyroid capsule was conducted to ensure the preservation of the parathyroid glands and recurrent laryngeal nerves (RLN) (Fig. 4). The resected thyroid and lymph node tissues were placed in a specimen bag and removed intact through the submental incision. Hemostasis was achieved using electrocautery, and a standard No. 10 vacuum drainage device was placed to ensure effective drainage of the surgical site. The incisions were closed with 4–0 absorbable sutures using an intradermal suturing technique.

Postoperatively, patients' vital signs were closely monitored, and all patients were allowed to start a liquid diet 6 h after surgery. Pain management primarily relied on acetaminophen, with prescription medication only provided for patients reporting significant pain. No antibiotics were administered to any patients postoperatively. The postoperative drainage was monitored and recorded daily, and the drainage tube was removed once the drainage volume decreased to less than 20 milliliters. Patients were scheduled for regular postoperative follow-ups.

Results

A total of 96 patients who underwent TSET were included in this study. 1 patient (1.0%) was converted to OT due to intraoperative bleeding, while the remaining 95 patients successfully completed TSET and were included in the final analysis (Table 1). The study population consisted of 15 males and 80 females, with a mean age of 48.7 ± 10.5 years (range: 24–69 years). Pathological results revealed that 41 patients were diagnosed with PTC, while 54 patients had benign nodules. A total of 48 patients underwent unilateral partial thyroidectomy, 6 underwent bilateral partial thyroidectomy, 38 underwent lobectomy with unilateral central neck dissection (UCND), and 3 underwent total thyroidectomy with UCND (Table 2). The mean tumor diameter in PTC patients was 8.2 ± 5.6 mm (range: 1.3–30.0 mm), while the mean tumor diameter in patients with benign nodules was 32.9 ± 7.6 mm (range: 20.0–40.0 mm). The mean operative time for all TSET procedures was 158.3 ± 40.1 min. Specifically, the mean time for unilateral partial thyroidectomy was 132.5 ± 26.8 min, for bilateral partial thyroidectomy was 161.5 ± 44.6 min, for lobectomy with UCND was 185.6 ± 30.2 min, and for total thyroidectomy with UCND was 218.7 ± 34.6 min. The average number of central lymph nodes dissected in PTC patients was 4.7 ± 2.8, with an average of 0.6 ± 1.3 positive lymph nodes. The mean postoperative hospital

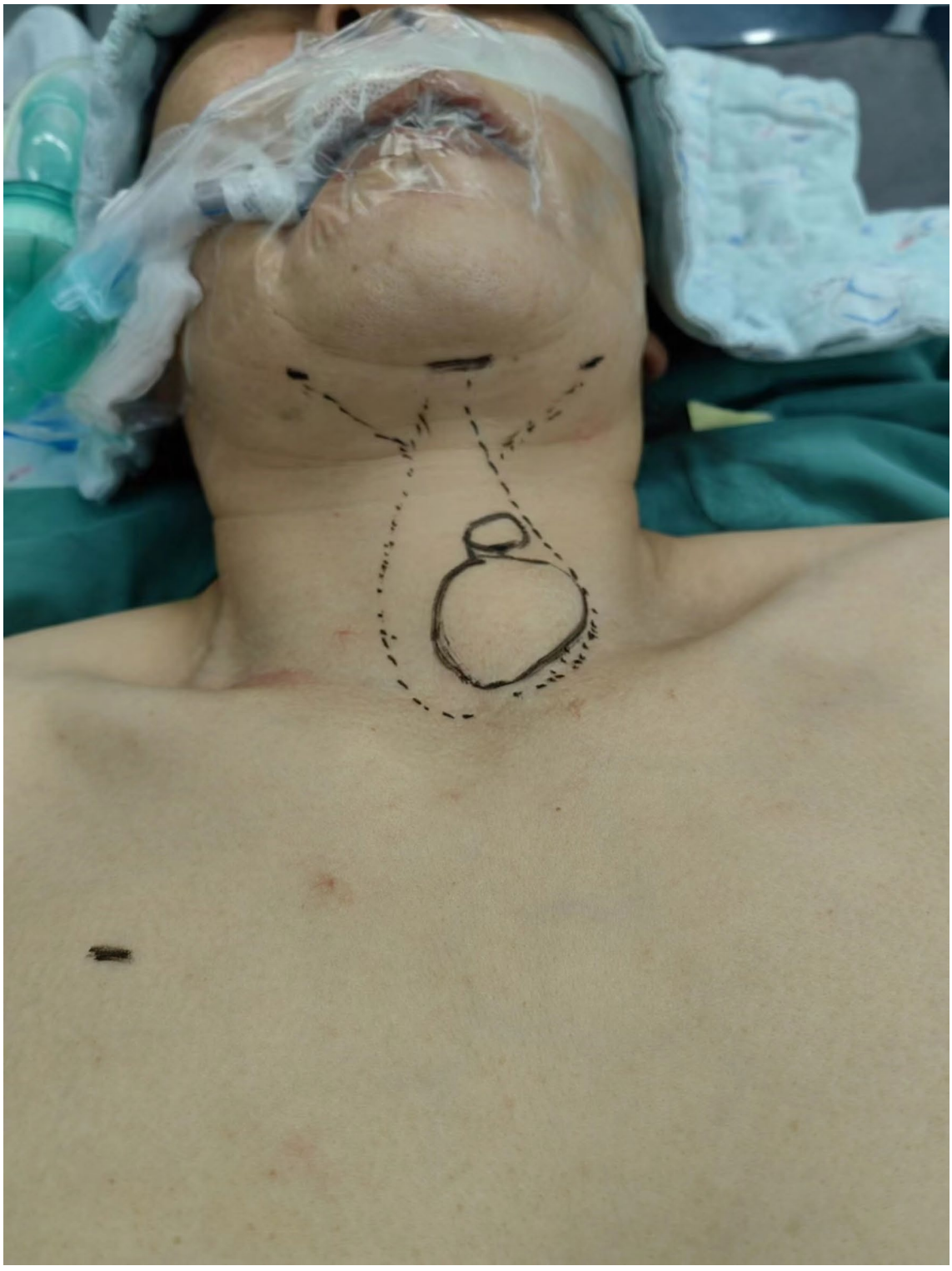

Fig. 1. Patient's position and skin marks.

stay was 3.6 ± 2.9 days (range: 2–30 days). Postoperatively, 2 cases of RLN injury causing vocal cord paralysis, 1 case of tracheal leak, and 1 case of chyle leak were observed. No cases of hypoparathyroidism, esophageal injury, bleeding, infection, or other complications were reported. The mean follow-up duration was 14.0 ± 7.7 months (range: 1–30 months).

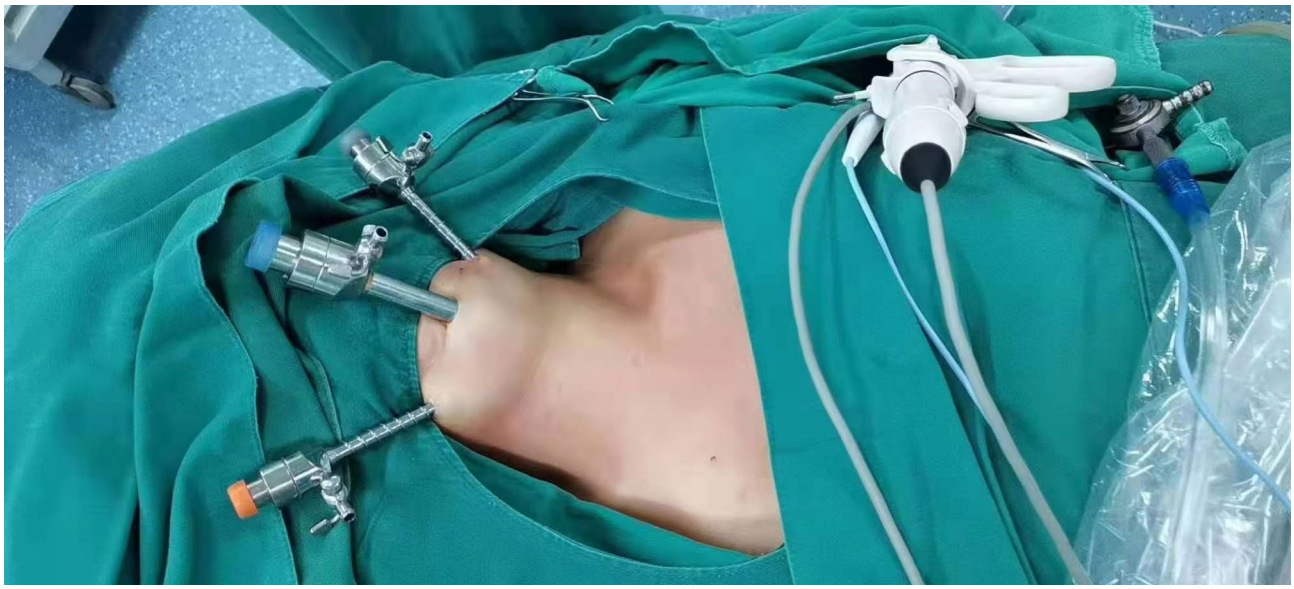

Fig. 2. Trocar positions.

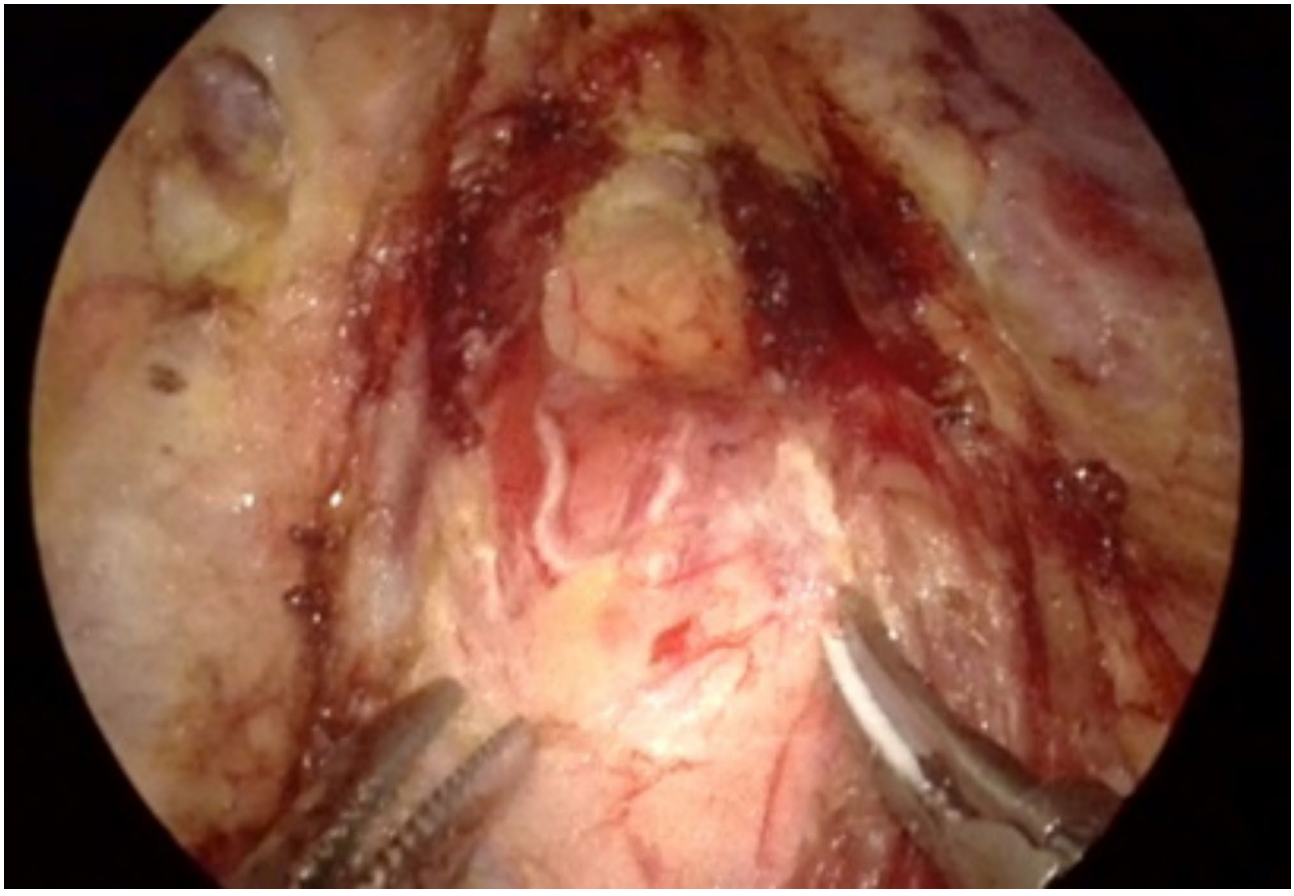

Fig. 3. The operative field during TSET.

Discussion

Since Hüscher et al. first performed endoscopic thyroid surgery in 1997[25], various surgical approaches have been developed[26,27]. The safety and feasibility of the oral approach have been widely validated and are well-received[21,28], but reports on the submental approach remain limited, with a small sample size[22,24,29]. Our study

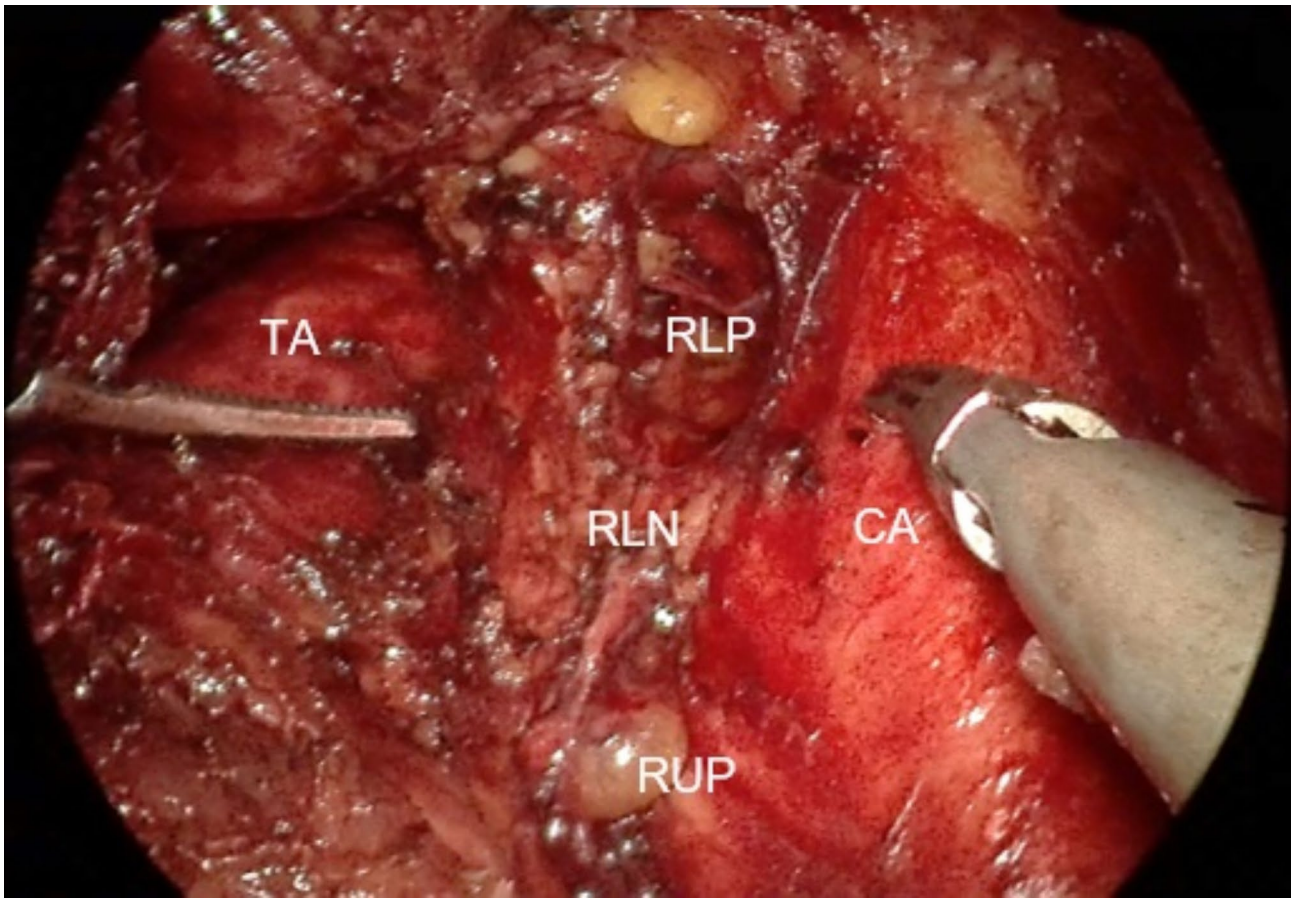

Fig. 4. A top-down anatomy after left thyroidectomy.

Variables	Value	Range/Percent
Age (mean ± SD, years)	48.7 ± 10.5	24–69
Gender		
Male	15	15.8%
Female	80	84.2%
Pathology		
PTC	41	43.2%
Benign	54	56.8%
Tumor size (mean ± SD, mm)		
Total	22.6 ± 14.0	1.3–40.0
PTC	8.2 ± 5.6	1.3–30.0
Benign	32.9 ± 7.6	20.0–40.0

Table 1. Clinical data of the study population (n = 95)

demonstrates that TSET is acceptable in terms of safety and feasibility, offering the same technical advantages as the oral approach. The submental approach modifies the entry point from the oral vestibule to the submental skin while maintaining the top-down operative technique, preserving the technical advantages of central lymph node dissection (Fig. 2). In the early phase, one patient was converted to open surgery due to bleeding at the medial edge of the sternocleidomastoid muscle. This was primarily due to a lack of experience and delayed hemostasis, resulting in unclear surgical visualization, rather than an issue of surgical safety. The remaining 95 patients underwent successful procedures with complete tumor resection, standardized and thorough lymph node dissection, and an average of 4.7 ± 2.8 lymph nodes removed (Table 2).

During the creation of the surgical workspace, TSET avoids the complex anatomy of the oral vestibule by operating in the submental subcutaneous area, reducing procedural difficulty and simplifying the establishment of the surgical space. Additionally, the loose nature of the neck skin facilitates the smooth extraction of specimens

Variables	Value	Range/Percent
Extent of Surgery		
Unilateral partial thyroidectomy	48	50.5%
Bilateral partial thyroidectomy	6	6.3%
lobectomy with UCND	38	40.0%
Total thyroidectomy with UCND	3	3.2%
No. of dissected LNs (mean ± SD, piece)	4.7 ± 2.8	1–16
No. of LN metastasis (mean ± SD, piece)	0.6 ± 1.3	0–6
Operative time (mean ± SD, min)		
Total	158.3 ± 40.1	80–300
Unilateral partial thyroidectomy	132.5 ± 26.8	80–191
Bilateral partial thyroidectomy	161.5 ± 44.6	120–230
lobectomy with UCND	185.6 ± 30.2	135–300
Total thyroidectomy with UCND	218.7 ± 34.6	186–255
Postoperative hospital stay (mean, days)	3.6 ± 2.9	2–30
Blood loss (mean ± SD, mL)	13.1 = 6.2	0–30
Volume of drainage (mean ± SD, mL)	92.1 = 41.5	23–215
Drainage tube removal time (mean ± SD, days)	3.3–0.8	2–6
Follow-up time (mean, months)	14.0 ± 7.7	1–30
Complication		
Recurrent laryngeal nerve paralysis		
Transient	2	2.1%
Permanent	0	0.0%
Hypoparathyroidism		
Transient	0	0.0%
Permanent	0	0.0%
Hematoma	0	0.0%
Chylous fistula	1	1.1%
Tracheal injury	1	1.1%
Esophageal injury	0	0.0%
Infection	0	0.0%

Table 2. Operative details and surgical outcomes of TSET (n = 95)

through the tunnel. Furthermore, this approach is distant from the mental nerve, effectively avoiding the risk of submental nerve injury unique to the oral approach[30]. Moreover, the surgical incision in TSET is classified as a Class I incision, significantly reducing the risk of incision infection compared to the Class II incision of the oral approach. Patients who underwent TSET did not receive antibiotics throughout the procedure, and no postoperative incision infections occurred.

The complication rate in our surgical approach was low, with no cases of permanent RLN injury or hypoparathyroidism observed. Two patients who underwent CND experienced transient recurrent laryngeal nerve palsy postoperatively, both of whom recovered following symptomatic neurotrophic treatment. In the early phase of the study, one patient developed a tracheal leak, which was completely resolved with conservative treatment. One patient developed a chyle leak postoperatively, with symptoms significantly improving after switching to a fat-free diet. No complications or tumor recurrence were detected in the remaining patients during the postoperative follow-up period.

In terms of aesthetic outcomes, TSET avoids the formation of anterior neck incision scars. All patients were satisfied with the postoperative cosmetic results, and no one reported dissatisfaction with the outcomes (Fig. 5). The aesthetic advantages of TSET include[1]: Reduced scar formation: TSET uses small incisions approximately 1 cm in diameter, resulting in minimal postoperative scarring compared to the larger incisions typical of OT[2]. Hidden incision: TSET places the incision below the chin in a concealed location, avoiding exposure in visible neck areas and thereby reducing the prominence of postoperative scars.

During communication with patients, we explicitly clarified that the subcutaneous tunnel in TSET is relatively long, and it is not a "minimally invasive surgery" in the traditional sense. These patients primarily chose TSET due to their pursuit of aesthetic outcomes. It is well known that quality of life is an important reference indicator for evaluating surgical efficacy. For patients seeking aesthetic improvements, noticeable scars may significantly impact their emotional state, often leading to negative emotional responses such as low self-esteem, embarrassment, or anxiety[31,32]. These negative emotional responses can adversely affect patients' quality of life, self-esteem, and social interactions. Therefore, surgeons should consider the patient's perspective, respect their preferences, and prioritize the aesthetic aspect, enabling patients to achieve psychological well-being alongside the cure of their disease.

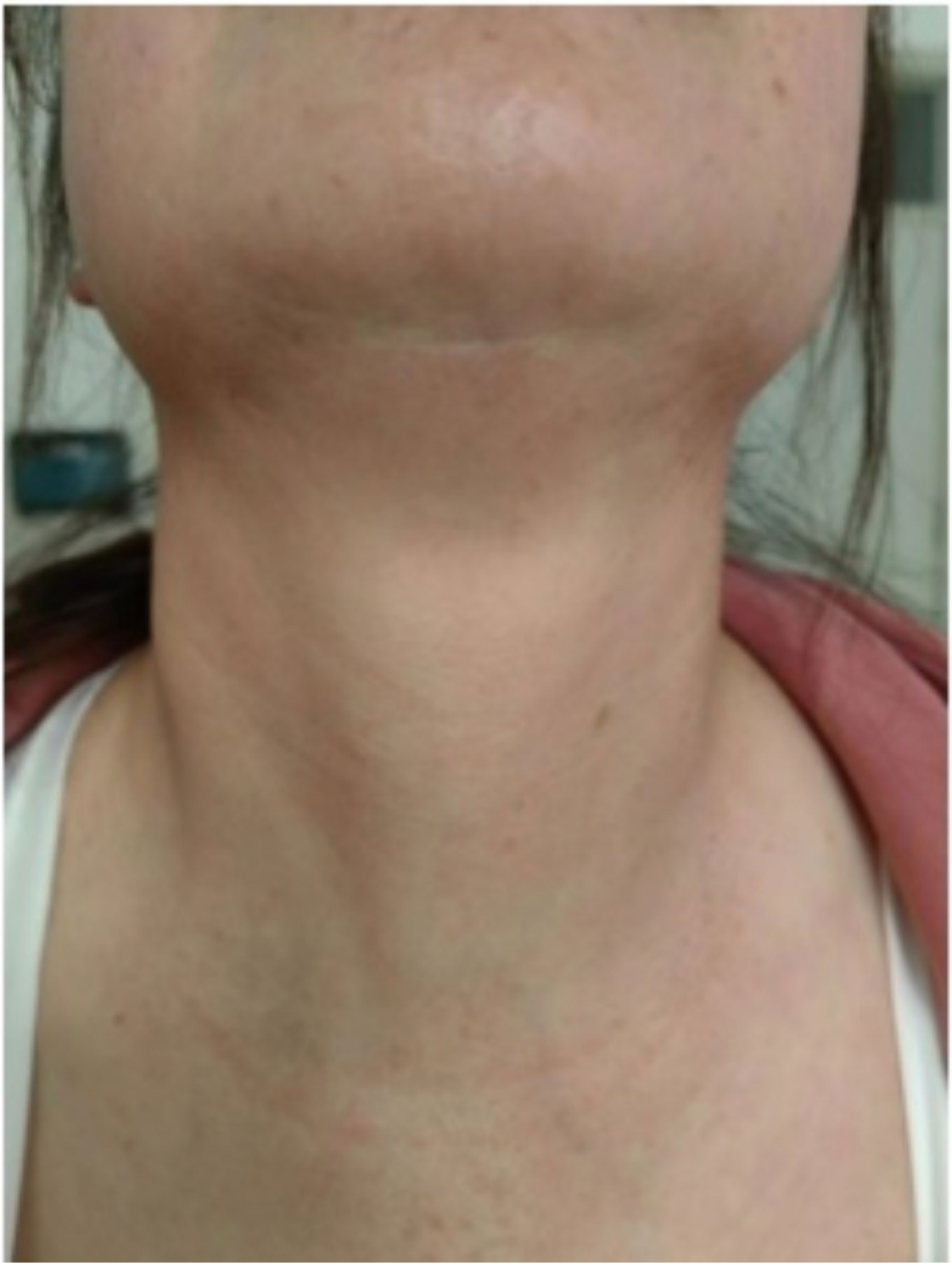

Fig. 5. A patient showing the incision 1 month after TSET.

However, TSET has some limitations. One patient was converted to open surgery due to intraoperative bleeding, and this conversion was considered a limitation of the TSET technique, recorded as a surgical failure. The conversion to open surgery directly resulted in a neck incision, compromising the primary cosmetic advantage of TSET. The operative time is relatively long, with an average operative time of 158.3 ± 40.1 min in this study. Although operative time may decrease with improved technical proficiency, the complexity of instrument preparation and the number of procedural steps still make the operative time significantly longer than open surgery[33]. Patient selection remains a key limitation of this technique. The exclusion criteria of this

study indicate that TSET is not suitable for patients with metastatic cervical lymph node disease, locally advanced thyroid cancer, and/or extensive anatomical involvement, restricting its application to carefully selected cases. Additionally, the limitations of this study include a relatively small patient cohort and a short follow-up duration. Future studies should conduct multi-center research with larger sample sizes and extended follow-up periods to further validate the safety and aesthetic outcomes of TSET.

In conclusion, TSET is a safe and feasible surgical technique that offers excellent cosmetic outcomes, making it an ideal choice for patients who prioritize aesthetic results.

Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Author contributions

Y.Z. and G.S. wrote the main manuscript text; G.S. prepared Figs. 1, 2, 3, 4 and 5 and T.B., H.H., Z.Z., W.B., Z.M. and R.T. collected the data; X.Y., T.H., T.S., X.D., Q.L., L.L. and Z.L. were responsible for data analysis and interpretation; All authors reviewed the manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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