



OPEN Postoperative quality of life in patients treated for thyroid cancer with transoral endoscopic and open surgery

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Thyroid cancer treatments often impact patients' quality of life (QOL). The transoral endoscopic thyroidectomy vestibular approach (TOETVA) gets lot attention as a scarless alternative, but its influence on postoperative QOL remains unclear. This study compares TOETVA and open surgery outcomes regarding postoperative QOL, scar satisfaction, and mental health in thyroid cancer patients to inform surgical decision-making. We retrospectively analyzed 221 thyroid cancer patients treated between January 2017 and September 2024: 136 underwent open surgery, and 85 had TOETVA. QOL was assessed using the EORTC QLQ-C30 and THYCA-QOL questionnaires. Scar appearance was evaluated with the Patient and Observer Scar Assessment Scale (POSAS), and mental health with the Hospital Anxiety and Depression Scale (HADS). EORTC QLQ-C30 scores showed no significant difference in overall QOL between TOETVA and open surgery (global health status: 81.31 vs. 83.43, $P = 0.420$). The open surgery group had higher summary THYCA-QOL scores (15.33 vs. 12.41, $P = 0.033$). While univariate analysis linked TOETVA to fewer thyroid cancer-specific symptoms ($P = 0.033$), multivariate analysis did not ($P = 0.198$). TOETVA patients had better scar satisfaction ($P < 0.001$), confirmed by univariate and multivariate analysis. Anxiety (95.0%) and depression (88.2%) were common, with anxious symptoms in the TOETVA group nearing significance ($P = 0.073$). TOETVA significantly improves thyroid cancer-specific QOL and scar satisfaction but shows no difference in overall QOL compared to open surgery. These insights may guide surgical decision-making. In addition, attention to managing anxiety and depression is also essential.

Keywords Thyroid cancer, Quality of life, Transoral endoscopic thyroidectomy, Open surgery

Based on the lasted Global Cancer Observatory (GLOBOCAN) 2022 data from the WHO International Agency for Research on Cancer, thyroid cancer has the seventh highest cancer incidence worldwide, accounting for 4.1% of all cancer cases¹. Surgical intervention, with or without radioactive iodine (RAI), is the primary curative treatment².

Thyroidectomy via an anterior neck incision has been widely employed due to its effectiveness and relatively low complication rates. However, the resulting neck scars may negatively impact patients' quality of life (QOL) and contribute to psychosocial stress³. In response, minimally invasive surgical techniques, especially the transoral endoscopic thyroidectomy vestibular approach (TOETVA) have gained attention as scar-free alternatives⁴. Some studies suggest that TOETVA offers better cosmetic outcomes and a comparable safety profile to open surgery, with similar oncological results^{5,6}. Nevertheless, patients with thyroid cancer often experience a reduced post-surgery quality of life compared to the general population^{7–9}.

In previous studies, specific impaired aspects of quality of life and their associated factors have varied. Some of the QOL issues specific to thyroid cancer and treatment have also not been adequately described. In additional, research comparing the impact of different surgical methods on postoperative physical, psychological and social

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well-being remained limited, particularly between TOETVA and open surgery. Further research using specific questionnaires is necessary.

Therefore, this study was designed to assess the postoperative quality of life, physical appearance and mental health in patients undergoing TOETVA and open surgery employing both generic and disease-specific questionnaires. Furthermore, we evaluated scarring and emotional well-being to inform the decision-making in surgical management of thyroid cancer.

Materials and methods

Study design and participants

This retrospective cross-sectional study was conducted through an online thyroid cancer surveillance platform and standardized questionnaires. The cohort included 673 individuals diagnosed with thyroid cancer and treated at Tongde Hospital, Zhejiang Province, from January 1, 2017, to September 1, 2024.

Inclusion criteria required: (1) diagnosis of thyroid cancer confirmed by pathological biopsy; (2) age of 18 years or older; (3) absence of distant metastasis; and (4) availability of comprehensive clinical data. Exclusion criteria included: (1) a history of neck surgery or radiotherapy (2) presence of comorbidities or other malignancies that could significantly influence treatment outcomes; (3) mental disorders or cognitive impairments; (4) underwent lateral neck dissection and (5) unwilling to participate or inability to complete follow-up.

Eligible patients were invited via an online link and provided informed consent. Standardized QOL questionnaires, along with scar and mental health assessments, were completed 1–3 months after surgery via online platforms, phone surveys, or in-person follow-ups. Incomplete or invalid survey data were re-collected within six months post-surgery. Data collection and verification were conducted by two research team members. The study protocol was approved by the Ethics Committee of Tongde Hospital, Zhejiang, and performed in accordance with relevant guidelines and regulations.

Measures

Patient demographic and clinical variables

A specific questionnaire was designed to collect demographic information, including age, gender, body mass index (BMI), marital status, educational background, employment, residence and monthly income. Clinical variables, such as type of surgery, tumor-related details were extracted from the surveillance system with patient consent and approval from the institutional ethics board. TNM staging for thyroid cancer was performed according to the 8th edition of the UICC/AJCC TNM classification system¹⁰. In addition, temporary hypoparathyroidism was defined as a parathormone level below 15.0 pg/ml on the first postoperative day¹¹.

Questionnaires regarding quality of life

The general quality of life was evaluated using the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30), designed for all patients with cancer. The global health status reflects overall QOL, with higher scores on the global health and functional subscales indicating better prognosis, while higher scores on the symptom subscales signal poorer quality of life¹². Moreover, the Thyroid Cancer-specific Quality of Life Questionnaire (THYCA-QOL) was used to evaluate symptoms specific to thyroid cancer¹³. The summary THYCA-QOL score, calculated as the average of the subscale scores, provides an overall measure of thyroid cancer-related QOL, with higher summary and subscale scores indicating worse quality of life⁷. Both the Chinese versions of the EORTC QLQ-C30 and THYCA-QOL has demonstrated robust reliability and validity^{14,15}.

Scar and mental health assessment

Scar satisfaction was evaluated by both researchers and respondents using the Patient and Observer Scar Assessment Scale (POSAS), with higher subscale scores indicating lower satisfaction with the scar from observer and patient¹⁶. In addition, mental health was assessed using the Hospital Anxiety and Depression Scale (HADS), and scores above 8 indicated the presence of depression or anxiety¹⁷. The reliability and validity of these scales have been confirmed in earlier research^{18,19}.

Statistical analysis

All analyses were performed using R (version 4.3.1) and RStudio software. Continuous variables were represented as means \pm standard deviation (SD) or medians with interquartile ranges (IQR), while categorical variables were expressed as frequencies and percentages. Differences in participant characteristics were analyzed using independent sample t-tests or one-way analysis of variance (ANOVA), alongside Chi-square test or the Fisher's exact tests. Subsequently, univariate and multivariate linear or logistic regression analyses were performed to identify factors influencing QOL, scar satisfaction and emotional well-being. A p-value of less than 0.05 was considered statistically significant.

Results

Study population and baseline characteristics

A total of 221 patients diagnosed with thyroid cancer were included in this study (Fig. 1). The participants were divided into two groups: 136 patients (61.5%) underwent open surgery, and 85 patients (38.5%) were treated with the transoral endoscopic approach. Baseline characteristics of each group are presented in Table 1.

The majority of participants were middle-aged (mean age: 44.21 ± 12.25 years) and female (65.6%). Most patients were diagnosed with papillary thyroid carcinoma (PTC, 94.12%) and classified as T1 (95.93%), and 91.86% of tumors were further identified as Stage 1. The results showed no significant differences in these

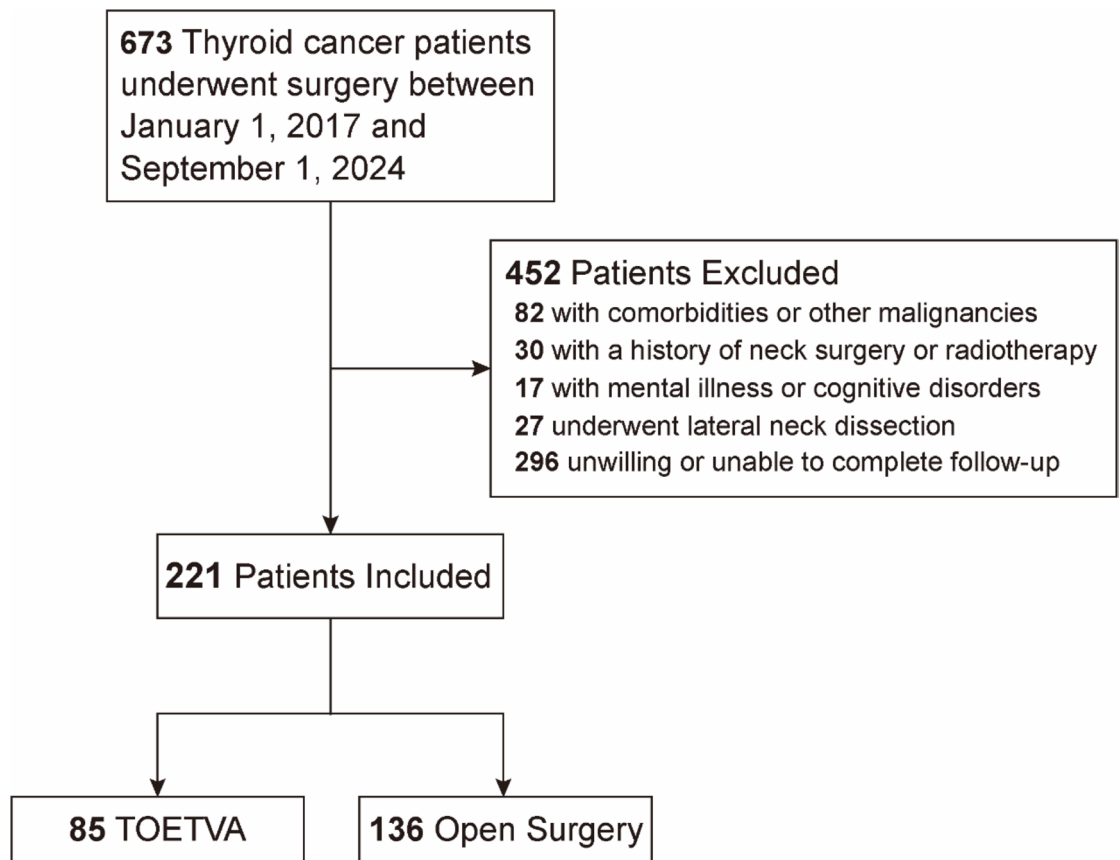


Fig. 1. Flow chart of the study process.

clinicopathological characteristics between patients underwent open surgery and those treated with TOETVA (all $P > 0.05$). Bilateral tumors were more common in the open surgery group (23.53% vs. 4.71%), whereas the TOETVA group had a higher proportion of tumors on the right side (54.12%) or the left side (38.82%). Partial thyroidectomy was more common in the TOETVA group than in the open surgery group (84.7% vs. 61.7%, $P < 0.001$). In addition, the risk of hypoparathyroidism was significantly lower in the TOETVA group (5.9% vs. 18.4%, $P = 0.008$). However, the median operative time for TOETVA was significantly longer, at 185 min (IQR: 149–229), compared to 103 min (IQR: 81.5–120.3) for open surgery ($P < 0.001$). Similar patterns were observed for hospital length of stay and total costs, with TOETVA patients experiencing longer stays and higher expenses.

Other demographic variables, including marital status, education level, and residence, also demonstrated statistically significant differences between the groups (all $P < 0.05$). Patients undergoing TOETVA were more likely to have higher educational attainment (70.6% with a college degree or above) and reside in urban areas (89.4%), though a greater proportion were single or widowed compared to those in the open surgery group. In addition, the TOETVA group generally tended to have better-paying jobs and incomes. These findings suggest that socioeconomic factors may influence the choice of surgical approach.

Quality of life in patients with thyroid cancer

General cancer quality of life

The results of the general QOL assessment are presented in Table 2; Fig. 2. The global QOL score from EORTC QLQ-C30 showed no significant difference between the TOETVA and the open surgery group (81.3 vs. 83.4, $P = 0.420$). Among the functional subscales, social and role functioning had the highest mean scores (94.5 and 94.2 respectively). Patients in the TOETVA group reported higher scores for physical, emotional, and cognitive functioning subscales, with only cognitive functioning reaching statistical significance compared to the open surgery group. For symptom subscales, the pain score was lower in the open surgery group compared to the TOETVA group (5.5 vs. 10.2, $P = 0.029$). Other symptoms scores, such as fatigue, nausea/vomiting, dyspnea, insomnia, appetite loss, and constipation/diarrhea, were elevated in the open surgery group, though these differences were not statistically significant.

We further conducted linear regression analyses to identify the determinants of general cancer QOL scores (Table 3). In univariate analysis, education level, residence, employment status, monthly household income, and age were significantly correlated with the global QOL score (all $P < 0.05$). These significant factors were then included in multivariable regression models. Multivariable stepwise analysis indicated that higher monthly household income, particularly levels exceeding 5000 ¥, was significantly associated with improved general QOL ($P < 0.05$). Other income levels did not demonstrate significant associations. Although trends suggested rural

Variables	Total (n=221)	Open surgery (n=136)	TOETVA (n=85)	P
Age, mean \pm SD	44.21 \pm 12.25	47.85 \pm 12.02	38.39 \pm 10.26	< 0.001
BMI, mean \pm SD	23.53 \pm 3.18	23.47 \pm 3.02	23.63 \pm 3.45	0.710
Tumor max diameter, M (Q ₁ , Q ₃)	0.70 (0.40, 1.00)	0.70 (0.50, 1.00)	0.70 (0.40, 1.00)	0.932
Surgery time, M (Q ₁ , Q ₃)	120.00 (95.00, 170.00)	103.00 (81.50, 120.25)	185.00 (149.00, 229.00)	< 0.001
Hospital duration, M (Q ₁ , Q ₃)	6.00 (5.00, 8.00)	6.00 (4.00, 8.00)	7.00 (5.00, 9.00)	0.004
Treatment costs, M (Q ₁ , Q ₃)	18.90 (17.41, 20.52)	18.46 (17.03, 19.90)	19.89 (18.15, 21.50)	< 0.001
Gender, n (%)				0.165
Female	145 (65.61)	94 (69.12)	51 (60.00)	
Male	76 (34.39)	42 (30.88)	34 (40.00)	
Type of thyroidectomy, n (%)				< 0.001
Partial	156 (70.59)	84 (61.76)	72 (84.71)	
Total	65 (29.41)	52 (38.24)	13 (15.29)	
Pathologic diagnosis, n (%)				0.557
PTC	208 (94.12)	127 (93.38)	81 (95.29)	
FTC	13 (5.88)	9 (6.62)	4 (4.71)	
T stage, n (%)				0.468
1	212 (95.93)	132 (97.06)	80 (94.12)	
2	9 (4.07)	4 (2.94)	5 (5.88)	
Nodal stage, n (%)				0.230
0	124 (56.11)	72 (52.94)	52 (61.18)	
N1a	97 (43.89)	64 (47.06)	33 (38.82)	
AJCC stage, n (%)				0.140
1	203 (91.86)	122 (89.71)	81 (95.29)	
2	18 (8.14)	14 (10.29)	4 (4.71)	
Tumor site, n (%)				< 0.001
Both right and left	36 (16.29)	32 (23.53)	4 (4.71)	
Isthmus	12 (5.43)	10 (7.35)	2 (2.35)	
Left	75 (33.94)	42 (30.88)	33 (38.82)	
Right	98 (44.34)	52 (38.24)	46 (54.12)	
Hypoparathyroidism, n (%)				0.008
No	191 (86.43)	111 (81.62)	80 (94.12)	
Yes	30 (13.57)	25 (18.38)	5 (5.88)	
Marital, n (%)				0.010
Married/live with partner	197 (89.14)	127 (93.38)	70 (82.35)	
Single/widowed	24 (10.86)	9 (6.62)	15 (17.65)	
Education, n (%)				< 0.001
College and above	104 (47.06)	44 (32.35)	60 (70.59)	
Elementary and below	32 (14.48)	29 (21.32)	3 (3.53)	
Junior high	52 (23.53)	40 (29.41)	12 (14.12)	
Senior high	33 (14.93)	23 (16.91)	10 (11.76)	
Residence, n (%)				< 0.001
Rural	60 (27.15)	51 (37.50)	9 (10.59)	
Urban	161 (72.85)	85 (62.50)	76 (89.41)	
Employment status, n (%)				< 0.001
Employed	175 (79.19)	100 (73.53)	75 (88.24)	
Retired	33 (14.93)	30 (22.06)	3 (3.53)	
Unemployed	13 (5.88)	6 (4.41)	7 (8.24)	
Monthly household income (¥), n (%)				< 0.001
< 1000	10 (4.52)	7 (5.15)	3 (3.53)	
> 10,000	73 (33.03)	31 (22.79)	42 (49.41)	
1000 ~ 3000	21 (9.50)	17 (12.50)	4 (4.71)	
3000 ~ 5000	46 (20.81)	36 (26.47)	10 (11.76)	
5000 ~ 10,000	71 (32.13)	45 (33.09)	26 (30.59)	
Primary treatment, n (%)				0.124
Surgery	215 (97.29)	130 (95.59)	85 (100.00)	
Surgery and RAI	6 (2.71)	6 (4.41)	0 (0.00)	
Continued				

Variables	Total (n = 221)	Open surgery (n = 136)	TOETVA (n = 85)	P
Depress, n (%)				0.668
No	26 (11.76)	15 (11.03)	11 (12.94)	
Yes	195 (88.24)	121 (88.97)	74 (87.06)	
Anxiety, n (%)				0.083
No	11 (4.98)	10 (7.35)	1 (1.18)	
Yes	210 (95.02)	126 (92.65)	84 (98.82)	

Table 1. Baseline characteristics of respondents. *N* = 221; *SD* standard deviation, *M* median, *IQR* interquartile range, *TOETVA* transoral endoscopic thyroidectomy vestibular approach, *PTC* papillary thyroid carcinoma, *FTC* follicular thyroid carcinoma, *RAI* radioiodine. Significant values are in bold.

Variables	Total (n = 221)	Open surgery (n = 136)	TEOTVA (n = 85)	P
Global health status, mean ± SD	82.13 ± 18.96	81.31 ± 19.23	83.43 ± 18.57	0.420
Physical, mean ± SD	92.16 ± 11.70	91.86 ± 11.38	92.63 ± 12.26	0.638
Emotional, mean ± SD	82.47 ± 19.22	81.19 ± 18.70	84.51 ± 19.97	0.212
Cognitive, mean ± SD	83.63 ± 19.85	80.64 ± 21.01	88.43 ± 16.87	0.003
Social, mean ± SD	94.57 ± 12.74	95.22 ± 10.52	93.53 ± 15.66	0.338
Role, mean ± SD	94.27 ± 11.78	94.00 ± 11.95	94.71 ± 11.56	0.664
Fatigue, mean ± SD	1.66 ± 0.54	1.67 ± 0.51	1.63 ± 0.58	0.569
Pain, mean ± SD	7.32 ± 13.50	5.51 ± 9.31	10.20 ± 18.02	0.029
Nausea/vomiting, mean ± SD	4.07 ± 10.71	4.04 ± 10.64	4.12 ± 10.88	0.961
Dyspnea, mean ± SD	16.14 ± 20.50	16.67 ± 20.69	15.29 ± 20.28	0.629
Insomnia, mean ± SD	31.52 ± 30.76	32.35 ± 31.41	30.20 ± 29.82	0.613
Appetite loss, mean ± SD	11.01 ± 18.10	11.27 ± 17.32	10.59 ± 19.39	0.785
Constipation, mean ± SD	21.42 ± 27.78	23.53 ± 29.57	18.04 ± 24.43	0.153
Diarrhea, mean ± SD	10.11 ± 19.68	10.29 ± 19.67	9.80 ± 19.80	0.858
Financial, mean ± SD	6.33 ± 16.52	6.13 ± 15.82	6.67 ± 17.67	0.814

Table 2. Summary scores and subscale scores of EORTC QLQ-C30. *N* = 221; *SD* standard deviation, *IQR* interquartile range, *EORTC QLQ-C30* European Organization for Research and Treatment of Cancer Quality of Life Questionnaire, *TOETVA* transoral endoscopic thyroidectomy vestibular approach. Significant values are in bold.

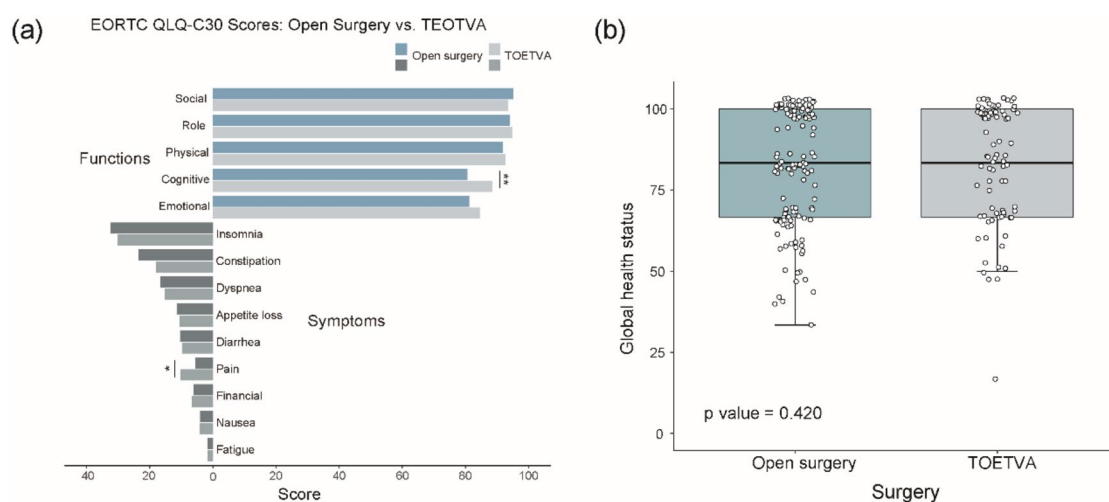


Fig. 2. Comparison of EORTC QLQ-C30 scores between the open surgery and TOETVA groups. (a) Displays the functional and symptom subscale scores for the open surgery and TOETVA groups, respectively. (b) Illustrates the global health status scores for both groups. There was no significant difference in global health status between the two groups ($P = 0.420$). *TOETVA* transoral endoscopic thyroidectomy vestibular approach. Statistical significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Variables	Univariate		Multivariate	
	P	β (95% CI)	P	β (95% CI)
Education				
College and above				
Elementary and below	<0.001	-12.40 (-19.68 ~ -5.12)	0.452	-3.84 (-13.82 ~ 6.14)
Junior high	0.002	-10.02 (-16.13 ~ -3.90)	0.407	-3.35 (-11.26 ~ 4.56)
Senior high	0.536	-2.28 (-9.47 ~ 4.92)	0.587	2.27 (-5.90 ~ 10.43)
Residence				
Rural				
Urban	0.002	9.02 (3.51 ~ 14.53)	0.837	0.73 (-6.24 ~ 7.71)
Employment status				
Employed				
Retired	0.204	-4.53 (-11.51 ~ 2.45)	0.648	-1.85 (-9.77 ~ 6.08)
Unemployed	0.016	-13.06 (-23.63 ~ -2.49)	0.095	-9.02 (-19.57 ~ 1.52)
Monthly household income (¥)				
<1000				
>10,000	<0.001	22.37 (10.58 ~ 34.17)	0.012	16.85 (3.83 ~ 29.88)
1000–3000	0.184	9.13 (-4.31 ~ 22.56)	0.369	6.55 (-7.70 ~ 20.80)
3000–5000	0.258	7.07 (-5.14 ~ 19.27)	0.576	3.66 (-9.15 ~ 16.47)
5000–10,000	0.003	17.84 (6.03 ~ 29.65)	0.047	12.99 (0.27 ~ 25.71)

Table 3. Associations between patient characteristics and EORTC QLQ-C30 global scores. *N*=221; *CI* confidence interval, *EORTC QLQ-C30* European Organization for Research and Treatment of Cancer Quality of Life Questionnaire. Significant values are in bold.

Variables	Total (<i>n</i> = 221)	Open surgery (<i>n</i> = 136)	TOETVA (<i>n</i> = 85)	<i>P</i>
Summary score, mean ± SD	14.21 ± 9.87	15.33 ± 10.04	12.42 ± 9.37	0.033
Neuromuscular, MEAN ± SD	10.91 ± 13.36	12.50 ± 13.35	8.37 ± 13.05	0.025
Voice, mean ± SD	14.40 ± 20.16	15.81 ± 21.69	12.16 ± 17.33	0.191
Concentration, mean ± SD	11.61 ± 16.84	13.97 ± 18.62	7.84 ± 12.75	0.004
Sympathetic, mean ± SD	13.65 ± 18.69	13.60 ± 18.83	13.73 ± 18.58	0.962
Throat/mouth problems, mean ± SD	15.23 ± 15.99	15.60 ± 15.79	14.64 ± 16.37	0.664
Psychological, mean ± SD	16.40 ± 17.01	17.34 ± 16.94	14.90 ± 17.11	0.301
Sensory, mean ± SD	16.52 ± 19.85	19.00 ± 20.80	12.55 ± 17.61	0.018
Problems with scar, mean ± SD	10.71 ± 20.37	14.71 ± 22.13	4.31 ± 15.25	<0.001
Felt chilly, mean ± SD	14.18 ± 20.84	16.42 ± 21.47	10.59 ± 19.39	0.038
Tingling hands/feet, mean ± SD	6.94 ± 15.64	8.09 ± 16.48	5.10 ± 14.09	0.167
Gained weight, mean ± SD	19.76 ± 26.72	21.32 ± 28.31	17.25 ± 23.91	0.272
Headache, mean ± SD	10.11 ± 17.79	11.03 ± 18.62	8.63 ± 16.39	0.330
Less interest in sex, mean ± SD	24.28 ± 26.56	19.85 ± 25.13	31.37 ± 27.39	0.002

Table 4. Summary scores and subscales scores of THYCA-QOL. *N*=221; *SD* standard deviation, *IQR* interquartile range, *THYCA-QOL* thyroid cancer-specific quality of life questionnaire, *TOETVA*, transoral endoscopic thyroidectomy vestibular approach. Significant values are in bold.

residence, lower education attainment, retirement or unemployment status, and old age appeared were linked to reduced quality of life, these associations did not reach statistical significance. The choice of surgical approach was not significantly associated with general cancer QOL in either univariate or multivariate settings.

Thyroid cancer-specific quality of life

Table 4; Fig. 3 present the thyroid cancer-specific QOL scores, focusing on adverse reactions experienced by patients and higher scores reflect poorer health-related outcomes. The mean summary THYCA-QOL score significantly higher in the open surgery group compared to the TOETVA group (15.3 vs.12.4, *P*=0.033). For symptom-specific subscales, the TOETVA group reported a higher score for decreased sexual interest (*P*=0.002). Aside from this, the open surgery group had higher scores across all the other subscales, and statistically significant differences were observed in neuromuscular symptoms, concentration difficulties, sensory disturbances, scar-related concerns and sensations of coldness (all *P*<0.05).

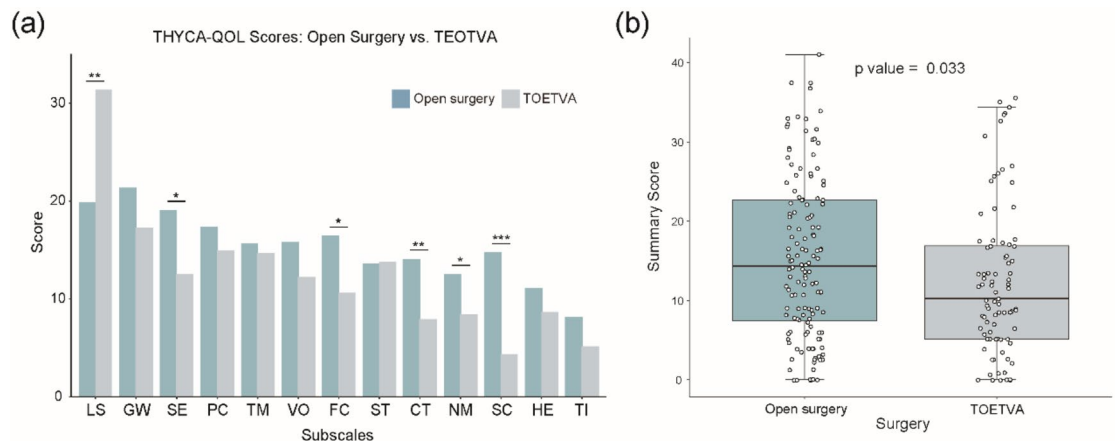


Fig. 3. Comparison of THYCA-QOL scores between the open surgery and TOETVA groups. **(a)** Displays the thyroid cancer specific symptom scores for the open surgery and TOETVA groups, respectively. **(b)** Illustrates the summary THYCA-QOL score for both groups, suggesting significant difference between the two groups ($P=0.033$). LS less interest in sex; GW gained weight, SE sensory, PC psychological, TM throat/mouth problems, VO voice, FC felt chilly, ST sympathetic, CT concentration, NM neuromuscular, SC problems with scar, HE headache, TI tingling hands/feet, TOETVA transoral endoscopic thyroidectomy vestibular approach. Statistical significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

In additional, associations between thyroid cancer-specific QOL and patient characteristics are detailed in Table 5. The results of univariate analysis showed that transoral endoscopic surgery was associated with a greater reduction in symptom scores ($\beta = -2.91$, 95%CI: -5.56 to -0.26 , $P=0.033$). However, this association did not remain significant in the multivariate model ($\beta = -2.06$, 95%CI: -5.18 to 1.07 , $P=0.198$). Similarly, other factors, such as male gender, unilateral tumor, partial resection, younger age, higher education level, and stable employment, were associated with lower scores in the univariate analysis, but these associations were not significant in the multivariate analysis.

Observer and patient scar assessment

Postoperative scars were evaluated using the POSAS scale, with results summarized in Table 6. The overall cosmesis score in both the Observer Scar Assessment Scale (OSAS) and Patient Scar Assessment Scale (PSAS) were higher in the open surgery cohort compared to the TOETVA group (OSAS: 3.6 vs. 2.5, $P < 0.001$; PSAS: 3.6 vs. 2.1, $P < 0.001$; Fig. 4). Except for the pain subscale, significant differences could be observed across all scale subscales ($P < 0.05$ for all except pain). The results of observer evaluations suggested that the most obvious differences in scar appearance compared to normal skin were in color, thickness, and softness subscales, consistent with patients' self-assessments. While mean scores for abnormal vascularity and scar size were lower than other subscales, they remained elevated in the open surgery group. In addition, patients who underwent open surgery reported higher levels of pain and itching associated with scarring.

Then, univariate analysis indicated that the surgical approach was significantly associated with OSAS and PSAS mean scores, and transoral endoscopic surgery was more effective in reducing the difference between scars and normal skin (OSAS: $\beta = -1.25$, 95% CI: -1.59 to -0.91 , $P < 0.001$; PSAS: $\beta = -1.54$, 95% CI: -2.16 to -0.93 , $P < 0.001$; Table 7). By the same token, unilateral tumors, particularly isthmus tumors were linked to lower scar assessment scores, while RAI treatment might induce raised OSAS scores. These findings were further confirmed in multivariate analysis. Despite minor impact, extended surgical time and hospital stay were found to reduce negative scores. Moreover, N0 stage, partial thyroidectomy and higher education levels were also linked to lower OSAS scores in univariate analysis (all $P < 0.05$).

Mental health assessment

We also evaluated the mental health status for all participants (Table 1). The results showed that the majority of thyroid cancer patients experienced anxiety (95.0%) and depression (88.2%). Those who underwent transoral endoscopic surgery exhibited a higher tendency toward anxious symptoms, with the difference approaching statistical significance ($P=0.083$).

Regression analyses were performed to explore factors associated with anxiety and depression, with detailed results presented in Supplement Tables 1 and 2. Univariate analysis showed that age, residence and surgical duration were significantly associated with depressive symptoms. In additional, patients with unilateral tumors and those undergoing TOETVA were more likely to experience anxiety. However, after adjusting for other variables, these associations did not remain significant in the multivariate analysis.

Variables	Univariate		Multivariate	
	<i>P</i>	β (95% CI)	<i>P</i>	β (95% CI)
Gender				
Female				
Male	0.059	-2.64 (-5.36 ~ 0.08)	0.437	-1.15 (-4.04 ~ 1.74)
Surgery				
Open surgery				
TOETVA	0.033	-2.91 (-5.56 ~ -0.26)	0.198	-2.06 (-5.18 ~ 1.07)
Type of thyroidectomy				
Partial				
Total	0.014	3.56 (0.74 ~ 6.38)	0.083	3.35 (-0.42 ~ 7.12)
Tumor site				
Both right and left				
Isthmus	0.131	-4.96 (-11.38 ~ 1.45)	0.140	-4.85 (-11.28 ~ 1.57)
Left	0.032	-4.30 (-8.20 ~ -0.40)	0.791	-0.64 (-5.36 ~ 4.08)
Right	0.119	-3.00 (-6.75 ~ 0.75)	0.770	0.69 (-3.91 ~ 5.28)
Marital				
Married/live with partner				
Single/widowed	0.096	-3.55 (-7.72 ~ 0.61)	0.467	-1.62 (-5.97 ~ 2.73)
Education				
College and above				
Elementary and below	0.211	2.48 (-1.39 ~ 6.35)	0.799	-0.65 (-5.62 ~ 4.32)
Junior high	0.020	3.89 (0.64 ~ 7.15)	0.235	2.43 (-1.57 ~ 6.43)
Senior high	0.058	3.72 (-0.11 ~ 7.55)	0.185	2.95 (-1.39 ~ 7.29)
Employment status				
Employed				
Retired	0.936	0.15 (-3.51 ~ 3.81)	0.170	-2.98 (-7.23 ~ 1.26)
Unemployed	0.089	4.84 (-0.71 ~ 10.38)	0.211	3.64 (-2.05 ~ 9.32)
Age	0.096	0.09 (-0.02 ~ 0.20)	0.603	0.04 (-0.11 ~ 0.19)

Table 5. Associations between patient characteristics and THYCA-QOL summary score. *N* = 221; *CI* confidence interval, *THYCA-QOL* thyroid cancer-specific quality of life questionnaire, *TOETVA* transoral endoscopic thyroidectomy vestibular approach. Significant values are in bold.

Variables	Total (<i>n</i> = 221)	Open surgery (<i>n</i> = 136)	TOETVA (<i>n</i> = 85)	<i>P</i>
OSAS				
Vascularity, mean \pm SD	2.25 \pm 1.09	2.63 \pm 0.95	1.64 \pm 1.02	< 0.001
Color, mean \pm SD	3.05 \pm 1.66	3.70 \pm 1.46	2.02 \pm 1.42	< 0.001
Thickness, mean \pm SD	2.72 \pm 1.39	3.15 \pm 1.21	2.02 \pm 1.39	< 0.001
Relief, mean \pm SD	3.59 \pm 1.71	4.16 \pm 1.56	2.69 \pm 1.55	< 0.001
Roughness, mean \pm SD	3.10 \pm 1.41	3.53 \pm 1.22	2.41 \pm 1.42	< 0.001
Surface area, mean \pm SD	2.40 \pm 1.19	2.80 \pm 1.06	1.76 \pm 1.12	< 0.001
Overall cosmesis observe, mean \pm SD	3.18 \pm 1.36	3.62 \pm 1.17	2.47 \pm 1.35	< 0.001
PSAS				
Pain, mean \pm SD	2.09 \pm 2.02	2.10 \pm 2.00	2.08 \pm 2.05	0.962
Itch, mean \pm SD	2.45 \pm 2.10	2.82 \pm 2.18	1.86 \pm 1.82	< 0.001
Color, mean \pm SD	3.06 \pm 2.48	3.70 \pm 2.54	2.05 \pm 2.00	< 0.001
Pliability, mean \pm SD	3.01 \pm 2.42	3.49 \pm 2.46	2.26 \pm 2.17	< 0.001
Thickness, mean \pm SD	2.86 \pm 2.32	3.32 \pm 2.41	2.13 \pm 1.97	< 0.001
Irregular, mean \pm SD	3.02 \pm 2.41	3.65 \pm 2.50	2.01 \pm 1.89	< 0.001
Overall cosmesis patient, mean \pm SD	3.02 \pm 2.30	3.57 \pm 2.31	2.13 \pm 1.99	< 0.001

Table 6. Summary scores and subscales scores of POSAS. *N* = 221; *SD* standard deviation, *IQR* interquartile range, *POSAS* patient and observer scar assessment scale, *OSAS* observer scar assessment scale, *PSAS* patient scar assessment scale, *TOETVA* transoral endoscopic thyroidectomy vestibular approach. Significant values are in bold.

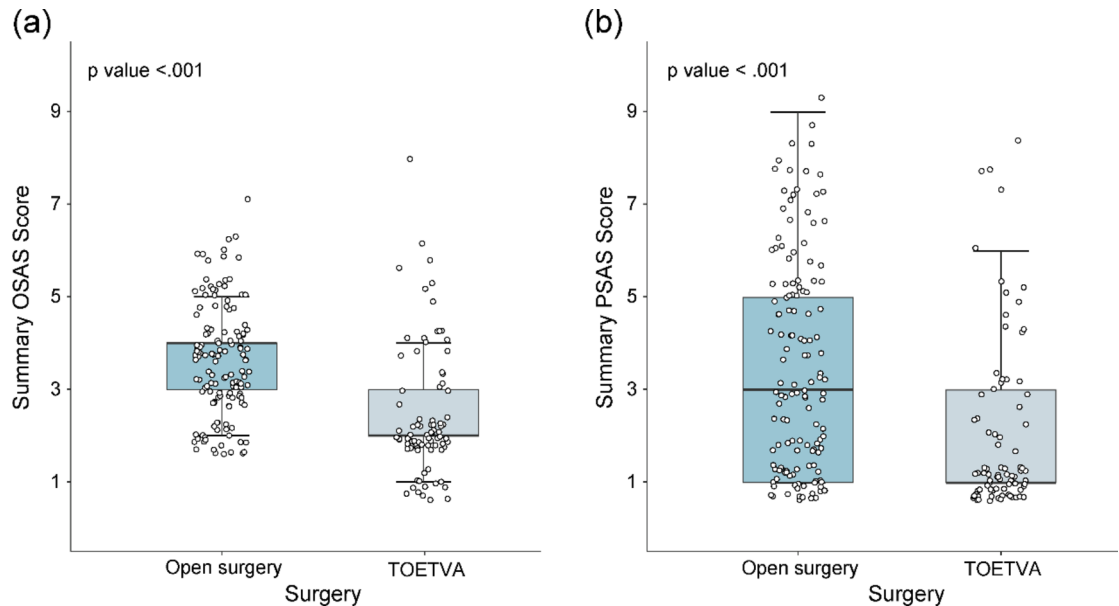


Fig. 4. Comparison of POSAS scores between the TOETVA and open surgery groups. **(a)** Comparison of overall OSAS scores between the open surgery and the TOETVA groups ($P < 0.001$); **(b)** Comparison of overall PSAS scores between the open surgery and TOETVA groups ($P < 0.001$). POSAS patient and observer scar assessment scale, PSAS patient scar assessment scale, OSAS observer scar assessment scale, TOETVA transoral endoscopic thyroidectomy vestibular approach.

Discussion

This study is the first to comprehensively evaluated postoperative QOL, scar satisfaction and mental health outcomes in thyroid cancer patients undergoing traditional open surgery and transoral endoscopic surgery. Our findings indicate significant advantages of TOETVA across multiple dimensions.

Consistent with previous research, our results have shown that thyroid cancer patients often experience impaired QOL following treatment for thyroid cancer²⁰. Despite no significant differences in general cancer QOL scores between two groups, patients in the TOETVA group demonstrated better thyroid cancer-specific QOL and reduced discomfort compared to the open surgery group. This difference was particularly pronounced among women, patients without hypoparathyroidism, those who were married or partnered, employed individuals, and those with higher educational attainment and income. In additional, regression analysis further confirmed that TOETVA was significantly associated with lower symptom scores. This aligns with the results from studies conducted by Nhuyen and Wongwattana et al.^{21,22}. Furthermore, transoral endoscopic surgery has been confirmed to be safe, with similar survival outcomes as open thyroidectomy^{23,24}. It also avoids neck incisions, reducing the negative impact on patients' image and improving their psychological well-being and long-term quality of life²³.

However, TOETVA is associated with longer operative duration and higher costs, which is supported by earlier study²⁵. Patients who chose this approach often had higher incomes and better employment and living conditions, suggesting that socioeconomic factors play a role in treatment choices and QOL outcomes. Mongelli et al. also reported that financial distress was common in thyroid cancer survivors and was associated poorer health-related QOL²⁶.

Our study found slightly higher postoperative pain scores in the TOETVA group. However, Anuwong et al. reported lower postoperative pain using visual analog scale (VAS) measures for TOETVA patients, suggesting that postoperative pain may warrant further investigation using standardized measures²⁵. Previous studies have highlighted the negative impact of thyroidectomy complications, and we focus on hypoparathyroidism in this study^{27,28}. Despite not completely avoiding, the rate of hypoparathyroidism in the TOETVA were significantly lower than that in the open surgery group. This suggests that TOETVA may have obvious advantage for protecting parathyroid function. However, some authors have reported similar total complication prevalence in both groups^{29,30}. Differences in sample size, patient characteristics, and variations in surgical techniques are factors that need to be considered in interpreting these findings. Furthermore, our results have shown the value of THYCA-QOL scale in offering a comprehensive assessment of patient well-being that extends beyond general cancer scales, aligning with prior studies^{7,13}.

We evaluated scars from observer and patient perspectives with 13 domains of POSAS scale. The results demonstrated that transoral endoscopic surgery significantly improved scar appearance and reducing scar-related discomforts. Scores for almost all symptom subscales were higher in the open surgery group, with the most notable differences in color, pliability and irregularity. In additional, better scar outcomes were observed in female patients and those who did not undergo partial thyroidectomy, had higher education and income, lived in urban areas, and had stable employment. Similar findings have been reported by Kim and Agne et al., further

Variables	Univariate		Multivariate	
	P	β (95% CI)	P	β (95% CI)
OSAS				
Surgery				
Open surgery				
TOETVA	<0.001	-1.15 (-1.48 ~ -0.81)	0.010	-0.68 (-1.20 ~ -0.17)
N stage				
0				
N1a	0.047	0.37 (0.01 ~ 0.72)	0.114	0.28 (-0.07 ~ 0.62)
Type of thyroidectomy				
Partial				
Total	0.044	0.40 (0.01 ~ 0.79)	0.430	0.20 (-0.29 ~ 0.68)
Tumor site				
Both right and left				
Isthmus	0.009	-1.17 (-2.04 ~ -0.30)	0.004	-1.21 (-2.02 ~ -0.41)
Left	0.009	-0.71 (-1.24 ~ -0.18)	0.576	-0.17 (-0.76 ~ 0.42)
Right	0.003	-0.79 (-1.30 ~ -0.28)	0.377	-0.26 (-0.84 ~ 0.32)
Education				
College and above				
Elementary and below	0.064	0.51 (-0.03 ~ 1.04)	0.839	-0.05 (-0.58 ~ 0.47)
Junior high	0.045	0.46 (0.01 ~ 0.91)	0.479	0.16 (-0.27 ~ 0.59)
Senior high	0.415	0.22 (-0.31 ~ 0.75)	0.813	-0.06 (-0.56 ~ 0.44)
Primary treatment				
Surgery				
Surgery and RAI	0.015	1.36 (0.27 ~ 2.45)	0.060	1.05 (-0.04 ~ 2.13)
Surgery time	<0.001	-0.01 (-0.01 ~ -0.01)	0.061	-0.00 (-0.01 ~ 0.00)
Hospital duration	0.064	-0.07 (-0.14 ~ 0.00)	0.477	-0.02 (-0.09 ~ 0.04)
PSAS				
Surgery				
Open surgery				
TOETVA	<0.001	-1.44 (-2.04 ~ -0.85)	0.065	-0.80 (-1.64 ~ 0.04)
Tumor site				
Both right and left				
Isthmus	0.004	-2.19 (-3.66 ~ -0.73)	0.005	-2.03 (-3.43 ~ -0.64)
Left	0.002	-1.43 (-2.32 ~ -0.54)	0.013	-1.12 (-2.00 ~ -0.24)
Right	0.013	-1.10 (-1.96 ~ -0.24)	0.068	-0.81 (-1.67 ~ 0.05)
Surgery time	<0.001	-0.01 (-0.02 ~ -0.01)	0.104	-0.01 (-0.01 ~ 0.00)
Hospital duration	0.022	-0.14 (-0.26 ~ -0.02)	0.230	-0.07 (-0.19 ~ 0.05)

Table 7. Associations between patient characteristics and summary scores of OSAS and PSAS. *N* = 221; *CI* confidence interval, *POSAS* patient and observer scar assessment scale, *OSAS* observer scar assessment scale, *PSAS* patient scar assessment scale, *TOETVA* transoral endoscopic thyroidectomy vestibular approach, *RAI* radioiodine. Significant values are in bold.

highlighting the role of TOETVA in enhancing scar outcomes^{31,32}. Overall, evaluations from both observer and patient perspectives suggest that transoral endoscopic surgery leads to superior scar appearance, wound healing, and patient satisfaction.

In additional, subscales scores of PSAS were higher than OSAS, suggesting that patients may perceive scars more acutely than observers. Assessing scarring from both perspectives may provide a more comprehensive evaluation.

The emotional well-being of thyroid cancer survivors was often impaired in our cohort. A substantial proportion of our respondents reported high rates of depression (88.24%) and anxiety (95.02%), exceeding those documented in previous studies³³. Patients in TOETVA group often may suffer more anxious emotion. In additional, the factors contributing to poor mental health differed from earlier research³³. Although our findings require further validation, they suggest that thyroid cancer survivors after surgery might be in more need of psychosocial support than could be expected.

This study has some limitations. First, the sample size, particularly in the TOETVA group, is relatively small, which may affect the statistical power of the findings. Second, the follow-up period was limited to 6 months post-surgery, restricting insights into the long-term impact of surgical methods on QOL. In additional, the

POSAS scale may have some limitations in evaluating mucosal wounds after transoral surgery: whether it can be achieved via more standardized wound assessment merits further study. Finally, the retrospective nature of our study may introduce certain biases.

Conclusion

In summary, our study suggests that transoral endoscopic surgery for thyroid cancer is associated with improved quality of life and greater scar satisfaction compared to traditional open surgery, though the choice of surgical method does not appear to significantly affect general cancer QOL outcomes. These findings may assist in decision-making for surgical approaches for thyroid cancer treatment, particularly when considering patient preferences and postoperative expectations. In addition, depression and anxiety of patients are also need attention.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Author contributions

XW and HL contributed equally to this work. XW and HL conceived and designed the study. HL and JH collected and analyzed the data. CH and WX performed data interpretation and statistical analysis. YD, BL and ZW assisted with manuscript preparation and data visualization. WG and XZ supervised the entire project and provided critical revisions to the manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of Tongde Hospital, Zhejiang.

Additional information

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1038/s41598-025-91291-7>.

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