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Original Article

A comparative study on the clinical efficacy and safety of conventional open thyroidectomy and bilateral areolar approach thyroidectomy

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Abstract: Objective: To compare the clinical outcomes and safety profiles of conventional open thyroidectomy and bilateral areolar approach thyroidectomy. Methods: A total of 72 patients who underwent endoscopic thyroidectomy at Ruijin Hospital, Shanghai Jiao Tong University School of Medicine between August 2021 and March 2024 were retrospectively included as the endoscopic group (EG). Sixty-five patients who underwent conventional open thyroidectomy during the same period served as the control group (CG). Baseline characteristics, intraoperative parameters, postoperative outcomes, pain levels, incidence of postoperative complications, and three-month Numerical Scoring System (NSS) aesthetic scores were compared between the two groups. Results: Compared to the CG, the EG had a longer operative time but experienced less intraoperative blood loss and a shorter hospital stay (both $P < 0.05$). Postoperative white blood cell counts and C-reactive protein levels were significantly lower in the EG (both $P < 0.05$). Visual Analogue Scale scores on postoperative days 1, 2, and 3 were also significantly lower in the EG (all $P < 0.05$). The incidence of complications was lower in the EG than in the CG ($P < 0.05$). At the three-month follow-up, the EG demonstrated significantly higher NSS aesthetic scores compared to the CG ($P < 0.05$). Multivariable analysis identified age ≥ 50 years, open surgery, operative time ≥ 130 minutes, and intraoperative blood loss ≥ 60 mL as independent risk factors for postoperative complications (all $P < 0.05$). Conclusion: Bilateral areolar approach thyroidectomy offers advantages over conventional open thyroidectomy, including reduced tissue trauma, faster postoperative recovery, lower pain levels, a reduced incidence of complications, and superior short-term aesthetic satisfaction.

Keywords: Conventional open thyroidectomy, bilateral areolar approach thyroidectomy, recovery process, postoperative pain, complications

Introduction

Thyroid cancer is currently the most prevalent endocrine malignancy, accounting for approximately 95% of all endocrine tumors and ranking as the seventh most common cancer in China [1, 2]. Multiple studies have reported a steady annual increase in its incidence, with a particularly alarming rise among younger individuals, especially young women [3, 4]. By 2030, thyroid cancer is projected to become the second most common malignancy among women and the ninth among men, placing it among the top five most prevalent cancers worldwide [5].

Surgical intervention remains a cornerstone in the treatment of thyroid cancer. Although conventional open surgery is widely used, clinical experience has shown that it often results in a 5-6 cm cervical scar, leading to considerable psychological and cosmetic concerns, particularly in young women and individuals prone to keloid formation [6, 7]. In recent years, the increasing emphasis on patient-centered care has heightened attention to surgical aesthetic outcomes [8]. Consequently, the development of safe and effective surgical techniques that minimize visible scarring has become a major focus among thyroid surgeons. Endoscopic techniques, initially introduced into clinical

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practice by French surgeon Mouret and later adapted for thyroid surgery, have undergone significant refinements over the past two decades, supported by a growing body of clinical evidence [9, 10]. Among these, total areolar thyroidectomy has gained prominence due to its superior aesthetic results [11]. However, some researchers argue that surgical decision-making in thyroid surgery should not be driven solely by cosmetic outcomes. While the transareolar approach offers aesthetic benefits, it also involves certain drawbacks, such as prolonged anesthesia time, increased procedural complexity, and extensive subcutaneous dissection of the anterior chest wall, which may compromise surgical safety [12].

This study aimed to compare the safety and efficacy of the bilateral areolar approach thyroidectomy and conventional open thyroidectomy, with the goal of elucidating the advantages and limitations of each technique and providing guidance for optimizing surgical strategies in the management of thyroid cancer.

Materials and methods

Study design and patient selection

This retrospective study was approved by the Ethics Committee of Ruijin Hospital, Shanghai Jiao Tong University School of Medicine before its implementation. Clinical data were retrieved from the hospital's information system, covering the period from August 2021 to March 2024, with three-month follow-up completed by June 2024. Patients who underwent thyroidectomy during this period were considered for inclusion. A total of 178 cases were initially identified, and screening was conducted based on the following inclusion and exclusion criteria:

Inclusion criteria: (1) Surgery performed by the same surgical team; (2) Preoperative color Doppler ultrasound showing nodules with a maximum diameter < 4 cm; (3) No cervical lymphadenopathy or structural abnormalities on preoperative evaluation; (4) Age between 18 and 65 years; (5) Complete baseline clinical data available; (6) Complete records of intraoperative and postoperative parameters, postoperative pain assessments, and complications; (7) Definitive pathological diagnosis established; (8) No involvement of the trachea, esophagus, or recurrent laryngeal nerve; (9) Completion of three-month postoperative follow-up; (10) First-time thyroid surgery; (11) Preoperative diagnosis of benign thyroid nodules or differentiated thyroid carcinoma (papillary or follicular) based on imaging (ultrasound, computed tomography, or magnetic resonance imaging) and fine-needle aspiration cytology (FNAC), with malignant cases classified according to the 2023 World Health Organization classification of thyroid tumors [2].

Exclusion criteria: (1) Presence of distant lymph node metastasis; (2) Pathological evidence of invasion into the thyroid capsule, blood vessels, or adjacent organs or tissues; (3) Severe malnutrition, immunological disorders, or severe hepatic or renal insufficiency; (4) History of prior malignancy or chemotherapy.

After applying these criteria, 137 patients were eligible for inclusion. Based on the surgical approach, patients were divided into two groups: the control group (CG, n = 65), comprising patients who underwent conventional open thyroidectomy, and the endoscopic group (EG, n = 72), comprising patients who underwent bilateral areolar approach thyroidectomy.

Data collection

This study was designed as a retrospective analysis. Prior to data collection, the required sample size was estimated using the formula for comparing the means of two populations in medical statistics:

$$N = \frac{2\delta^2 (t_\alpha + t_\beta)^2}{(\mu_1 - \mu_2)^2}$$

In this formula, δ represents the standard deviation of the two populations, typically selected as the larger of the two sample standard deviations, while μ_1 and μ_2 denote the population means, estimated using the sample means.

By substituting the mean and standard deviation of the Numerical Scoring System (NSS) scores into the formula, with a statistical power of 0.8 and a significance level of $\alpha = 0.05$, the minimum required sample size per group was calculated to be 60 participants.

Clinical data from the 137 included patients were retrieved from the hospital information

system, covering the following aspects: (1) General information: Sex, age, body mass index (BMI), tumor diameter, tumor location, and educational level; (2) Intraoperative parameters: Operative time, intraoperative blood loss, number of lymph node dissections, and incidence rates of recurrent laryngeal nerve injury and parathyroid injury; (3) Postoperative outcomes: Postoperative length of stay, drain output, drain duration, and white blood cell (WBC) counts and C-reactive protein (CRP) levels at admission and on postoperative day 1; (4) Postoperative pain: Pain levels were assessed using the Visual Analogue Scale (VAS) on postoperative days 1, 2, and 3. The VAS is a 10-point scale [13], where 0 represents no pain and 10 indicates the most severe pain. Patients selected the score that best reflected their subjective pain experience; (5) Postoperative complications: The incidence of complications, including hoarseness, subcutaneous fluid accumulation, lymphorrhea, choking when drinking water, mouth corner injury, hematoma, and paresthesia, was recorded during the three-month follow-up period; (6) Aesthetic satisfaction: Before discharge, patients were informed about a scheduled follow-up three months after surgery, with telephone reminders provided closer to the date. Aesthetic satisfaction was assessed using the NSS score [14], ranging from 0 to 10, with higher scores indicating better aesthetic outcomes. Additionally, a 0-3 grading system was used to evaluate scar-related satisfaction, where 0 indicated dissatisfaction with prominent scarring and 3 indicated high satisfaction with minimal scarring; (7) Thyroid function: Differences in thyroid function markers, including free triiodothyronine (FT3), free thyroxine (FT4), and thyroid-stimulating hormone (TSH), were compared between the two groups preoperatively and at three months postoperatively.

Outcome measures

This study aimed to evaluate the safety, surgical trauma, and aesthetic outcomes associated with conventional open thyroidectomy versus bilateral areolar approach thyroidectomy. Outcome indicators were categorized into three domains: (1) Surgical safety, including operative time, intraoperative blood loss, and complication rates; (2) Extent of surgical trauma, including levels of inflammatory markers and pain assessment scores; (3) Aesthetic outcomes, including NSS scores and patient satisfaction.

It was hypothesized that, compared with conventional open surgery, bilateral areolar approach thyroidectomy would demonstrate superior therapeutic efficacy, reduced tissue trauma, faster postoperative recovery, enhanced safety, lower complication rates, and improved aesthetic outcomes at follow-up.

Risk factor analysis: Multivariable logistic regression analysis was performed, using the occurrence of postoperative complications as the dependent variable and clinical parameters as independent variables, to identify independent risk factors for complications.

Statistical methods

Statistical analysis was conducted using SPSS version 25.0. Quantitative variables, such as age and VAS scores, were assessed for normality and presented as mean ± standard deviation (mean ± SD). Intergroup comparisons of continuous variables were performed using independent-samples t-tests. Repeated measures analysis of variance was applied for comparisons across multiple time points. Categorical variables were expressed as percentages and compared using the χ^2 test. Multivariable logistic regression analysis was employed to identify independent risk factors for postoperative complications. A two-tailed P value < 0.05 was considered statistically significant.

Results

Comparison of baseline clinical data

Baseline characteristics, including sex, age, BMI, tumor location, and educational level, were collected and compared between the two groups. The proportion of patients with an undergraduate degree or higher was significantly greater in the EG than in the CG ($P < 0.05$). No statistically significant differences were observed in other baseline variables (all $P > 0.05$), as shown in **Table 1**.

Comparison of surgical safety indicators

Perioperative indicators: Perioperative data, including operative time, intraoperative blood loss, number of lymph node dissections, and

Table 1. Comparison of baseline clinical characteristics between the two groups

General clinical data		EG (n=72)	CG (n=65)	t/χ^2	*P*
Sex	Male	31.94%	24.62%	0.236	0.813
	Female	68.06%	75.38%		
Average age (years)		37.51±10.23	41.13±11.81	0.336	0.651
Average BMI (kg/m^2)		23.26±3.26	23.44±2.98	0.426	0.516
Tumor diameter (mm)		30.23±7.56	31.26±8.05	0.371	0.601
Tumor location	Left	52.78%	49.23%	0.669	0.298
	Right	47.22%	50.77%		

EG: endoscope group; CG: control group; BMI: body mass index.

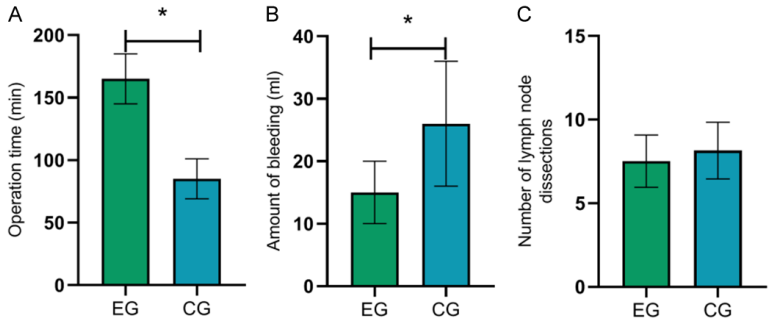

Figure 1. Comparison of operative time, intraoperative blood loss, and number of lymph node dissections. The EG exhibited longer operative time (A) and lower intraoperative blood loss (B) compared to the CG ($P < 0.05$). No significant difference was observed in the number of lymph node dissections (C) between the two groups ($P > 0.05$). EG: endoscope group; CG: control group. $^*P < 0.05$.

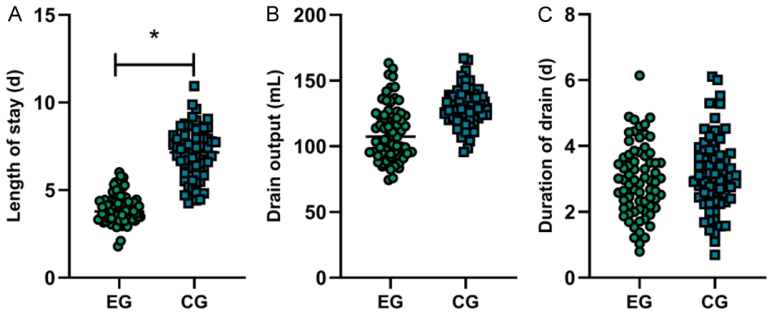

Figure 2. Comparison of length of stay, drain output, and drain duration between the two groups. The length of stay (A) in the EG was shorter than that in the CG ($P < 0.05$). There were no statistically significant differences in drain output (B) and drain duration (C) between the two groups ($P > 0.05$). EG: endoscope group; CG: control group. $^*P < 0.05$.

rates of recurrent laryngeal nerve and parathyroid injury, were collected. The EG had a significantly longer operative time but lower intraoperative blood loss compared to the CG (both P < 0.05), as shown in **Figure 1**. No significant differences were found between the two groups regarding the number of lymph node dissections, recurrent laryngeal nerve injury rates (38.89% in EG vs. 41.67% in CG), or parathyroid injury rates (5.56% in EG vs. 6.94% in CG) (all P > 0.05).

Postoperative rehabilitation indicators: The postoperative hospital stay was significantly shorter in the EG compared to the CG (P < 0.05). However, no significant differences were observed between the two groups in terms of drain output or drain duration (both P > 0.05), as shown in **Figure 2**.

Postoperative incidence of complications: In the EG, there were three cases of hoarseness, one case of subcutaneous fluid accumulation, one case of lymphorrhea, one case of choking when drinking water, and one case of hematoma, resulting in an overall complication rate of 9.72% (7/72). This was significantly lower than the complication rate of 18.46% (12/65) observed in the CG ($P < 0.05$).

Analysis of risk factors for postoperative complications: Using the presence or absence of postoperative complications as the dependent variable (0 = no complications; 1 = complications) and variables such as sex, age, and BMI as independent variables, univariate analysis revealed significant associations between com-

Table 2. Univariate analysis of postoperative complications

General clinical data		Absence of complications (n = 115)	Presence of complications (n = 22)	t/χ^2	*P*
Sex	Male	28	8	2.176	0.140
	Female	87	14		
Average age (years)		42.81±11.23	51.26±12.21	3.285	0.001
Average BMI (kg/m^2)		23.76±3.21	25.81±3.65	2.956	0.005
Surgical modality	Endoscope	65	7	4.624	0.031
	Open	50	15		
Tumor diameter (mm)		2.31±0.75	3.01±0.98	4.569	< 0.001
Operative time (minute)		115.62±28.51	136.98±32.12	3.695	< 0.001
Intraoperative blood loss (mL)		42.63±15.21	68.51±23.15	6.596	< 0.001
Number of lymph node dissections		6.23±2.12	8.76±2.51	4.652	< 0.001

BMI: body mass index.

Table 3. Multivariable logistic regression analysis of complications after thyroidectomy

Risk factors	B	S.E.	Wald	OR	95% CI	*P*
Age ≥ 50 years	0.782	0.353	4.902	2.186	1.094-4.365	0.027
Open surgery	0.892	0.362	6.073	2.440	1.201-4.957	0.014
Operative time ≥ 130 minutes	0.475	0.298	2.538	1.608	0.896-2.886	0.111
Intraoperative blood loss ≥ 60 mL	0.827	0.334	6.126	2.286	1.188-4.399	0.013

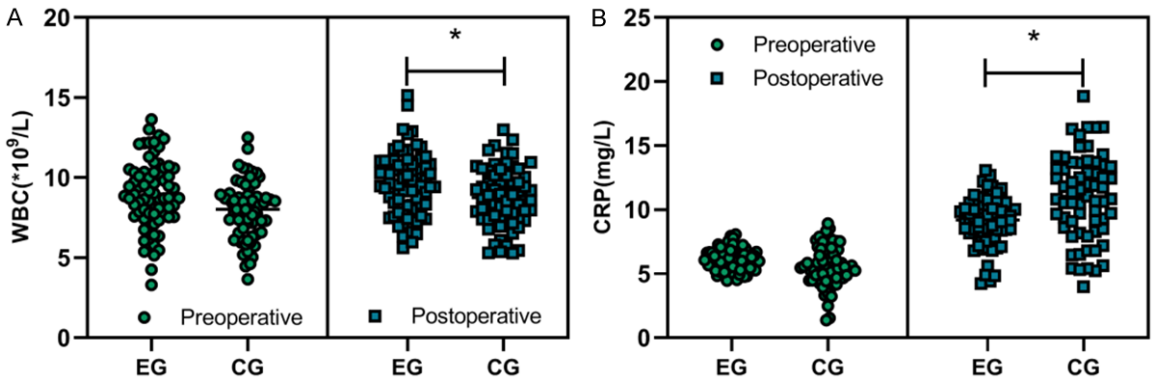

Figure 3. Comparison of preoperative and postoperative inflammatory marker levels between the two groups. No statistically significant differences were observed in the preoperative WBC (A) and CRP (B) levels between the two groups ($P > 0.05$). Postoperative WBC counts and CRP levels in the EG were significantly lower than those in the CG ($P < 0.05$). EG: endoscope group; CG: control group; WBC: while blood cell; CRP: C-reactive protein. $^*P < 0.05$.

plications and age, BMI, tumor diameter, operative time, intraoperative blood loss, and the number of lymph node dissections (**Table 2**).

Subsequent multivariable logistic regression analysis identified age ≥ 50 years, open surgery, operative time ≥ 130 minutes, and intraoperative blood loss ≥ 60 mL as independent risk factors for postoperative complications (P < 0.05), as shown in **Table 3**.

Comparison of surgical trauma extent indicators

Preoperative and postoperative inflammatory markers: There were no significant differences in preoperative WBC counts or CRP levels between the two groups (both P > 0.05). However, postoperative WBC counts and CRP levels were significantly lower in the EG compared to the CG (both P < 0.05), as shown in **Figure 3**.

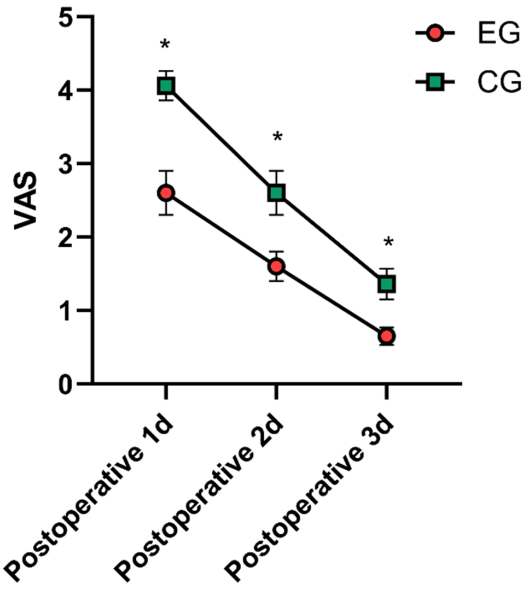

Figure 4. Comparison of postoperative pain intensity between the two groups. On postoperative days 1, 2, and 3, VAS scores in the EG were significantly lower than those in the CG ($P < 0.05$). EG: endoscope group; CG: control group; VAS: Visual Analogue Scale. *$P < 0.05$.

Postoperative pain intensity: VAS scores on postoperative days 1, 2, and 3 were significantly lower in the EG compared to the CG ($P < 0.05$), as shown in **Figure 4**.

Comparison of postoperative thyroid function indicators

No significant differences in thyroid function parameters (FT3, FT4, and TSH) were observed between the two groups either preoperatively or at three months postoperatively (all $P > 0.05$), as illustrated in **Figure 5**.

Comparison of aesthetic outcome indicators

At the three-month follow-up, the EG demonstrated significantly higher NSS aesthetic scores compared to the CG (7.02 ± 1.63 vs. 4.63 ± 1.23; $P < 0.05$). Additionally, a greater proportion of patients in the EG reported an aesthetic satisfaction score of 3 (51.17% vs. 20.00%) and a scar concern score of 0 (59.72% vs. 29.23%) compared to the CG ($P < 0.05$), as shown in **Figure 6**.

Discussion

Thyroid cancer is the most common malignancy of the endocrine system, accounting for approximately 1% of all cancers. Among its subtypes, papillary thyroid carcinoma is the most prevalent, characterized by a relatively favorable prognosis and a marked sex disparity, with incidence rates in women approximately twice those in men [15, 16]. Epidemiological data indicate that thyroid cancer can occur at any age, although it is most commonly diagnosed in young and middle-aged adults, with a growing trend toward earlier onset in recent years [17]. Surgical resection remains the cornerstone of treatment, significantly improving both survival rates and quality of life [18]. With advances in minimally invasive techniques and the increasing emphasis on patient-centered care, the bilateral areolar approach for thyroidectomy has emerged as a novel treatment option offering distinct advantages. This study systematically evaluated the clinical value of this approach compared with conventional open thyroidectomy from three perspectives: surgical safety, surgical trauma, and aesthetic outcomes.

In terms of surgical safety, the findings revealed that patients in the EG undergoing the areolar approach experienced significantly less intraoperative blood loss than those in the CG undergoing conventional open surgery, despite a longer operative time, consistent with the findings of Karakas et al. [19]. The extended duration of endoscopic surgery may be attributed to several factors: (1) a restricted visual field; (2) the need for meticulous dissection to protect critical structures; and (3) the additional time required for access establishment and wound closure. Despite the longer operative time, no significant differences were observed between the two groups in terms of the number of lymph node dissections or the incidence of injuries to key anatomical structures. These findings are consistent with previous research involving 508 patients, which concluded that although the areolar approach may prolong operative time, it does not compromise surgical radicality or safety and may even reduce intraoperative bleeding due to more precise dissection [20].

Additionally, a further analysis demonstrated that proactive preoperative assessment and preparation can significantly reduce intraoperative blood loss when utilizing the areolar approach [21]. This advantage is likely due to the magnification effect provided by endoscop-

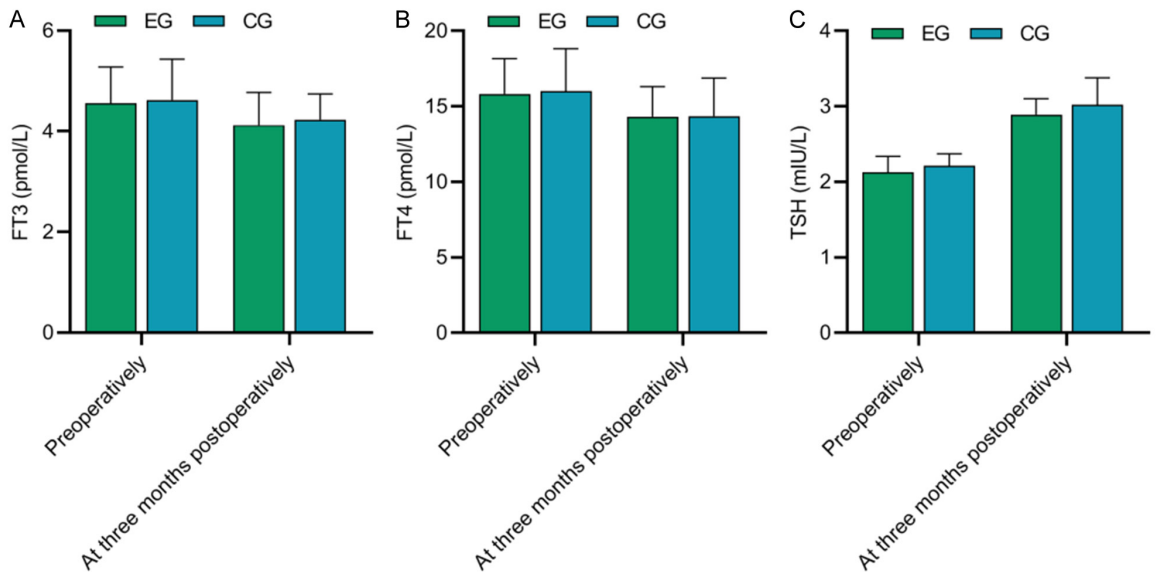

Figure 5. Comparison of postoperative thyroid function indicators between the two groups. No statistically significant differences were observed in FT3 (A), FT4 (B), and TSH (C) between the two groups preoperatively and at three months postoperatively ($P > 0.05$). EG: endoscope group; CG: control group; FT3: free triiodothyronine; FT4: free thyroxine; TSH: thyroid-stimulating hormone.

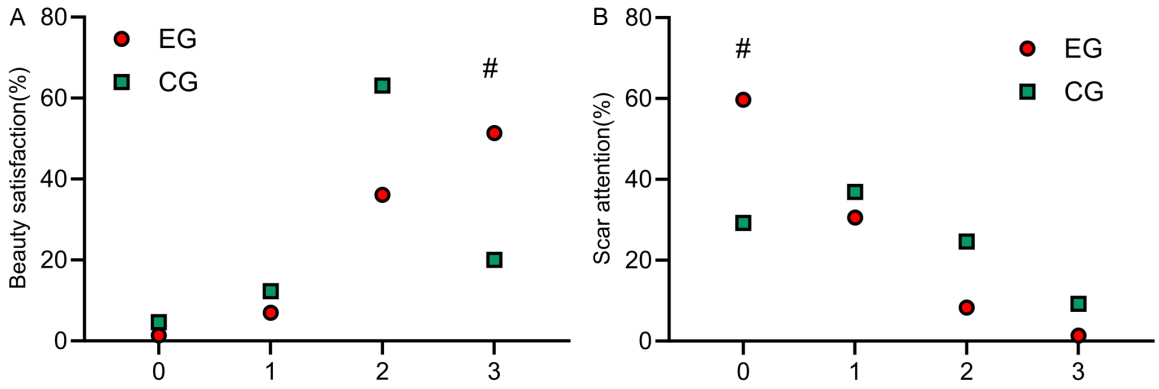

Figure 6. Comparison of aesthetic outcome indicators between the two groups. A greater proportion of patients in the EG reported an aesthetic satisfaction score of 3 (51.17% vs. 20.00%) (A) and a scar concern score of 0 (59.72% vs. 29.23%) (B) compared to the CG ($P < 0.05$). EG: endoscope group; CG: control group.

ic visualization, which enhances surgical precision and improves exposure of deeper tissues.

Regarding surgical trauma, this study innovatively incorporated inflammatory biomarkers to assess the extent of tissue injury. Postoperative WBC counts and CRP levels were significantly lower in the EG compared to the CG. Prior research has established that elevated inflammatory markers are associated with adverse postoperative outcomes. For example, Sun et al. [22] reported a significant correlation between inflammatory marker levels and postoperative chronic pain. Similarly, Sideris et al. [23] found that elevated systemic inflammation increases the risk of postoperative infections, while Yin et al. [24] highlighted the association between inflammation and postoperative mood disorders.

In this study, the lower VAS scores and complication rates observed in the EG indirectly support the link between reduced inflammatory responses and improved postoperative recovery. This assumption is further corroborated by the shorter length of hospital stay observed in

the EG, suggesting that endoscopic surgery not only facilitates faster recovery but also reduces hospitalization costs and optimizes healthcare resource utilization.

The NSS was used to quantitatively assess postoperative aesthetic outcomes. The results demonstrated that patient satisfaction in the EG was significantly higher than that in the CG, consistent with the findings of Cao et al. [25]. Further analysis indicated that patients with higher educational levels were more likely to opt for thyroidectomy via the areolar approach, reflecting a growing emphasis on aesthetic outcomes among contemporary patients. This trend highlights a broader shift in healthcare, from a sole focus on disease management to a more holistic approach that includes rehabilitation and quality of life.

The areolar approach conceals the surgical incision within the areolar region, effectively eliminating the visible permanent scarring associated with traditional cervical incisions. It also allows for more flexible management of bilateral lesions, making it particularly attractive to younger female patients [26]. Furthermore, follow-up data revealed that scar-related concerns were significantly lower in the EG compared to the CG, suggesting a distinct long-term aesthetic advantage [27, 28]. These findings provide valuable guidance for clinical decision-making, particularly for patients prone to keloid formation.

In conclusion, compared with conventional open thyroidectomy, bilateral areolar approach thyroidectomy demonstrates clear advantages, including reduced tissue trauma, faster recovery, lower postoperative pain, a lower incidence of complications, and improved short-term aesthetic satisfaction.

The innovations of this study are reflected in three key aspects: First, it is among the first to systematically evaluate surgical trauma based on inflammatory responses, providing new quantitative indicators for trauma assessment. Second, it utilizes a standardized scoring system to objectively quantify aesthetic outcomes, enhancing the reliability of cosmetic evaluations. Third, it establishes a multidimensional evaluation framework encompassing surgical safety, trauma extent, and aesthetic outcomes, offering a comprehensive reference for clinical decision-making.

Nonetheless, certain limitations must be acknowledged. As a retrospective study, it is subject to potential information and selection biases, which may impact the accuracy and generalizability of the findings. Moreover, the relatively short follow-up period limits the assessment of long-term efficacy and complication rates. Therefore, future prospective studies with larger sample sizes and extended follow-up durations are warranted to validate and further clarify these findings.

Disclosure of conflict of interest

None.

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