

Original Article

Effects of endoscopic sinus surgery on clinical outcomes, nasal patency, and olfactory function in patients with chronic rhinosinusitis

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Abstract: Objective: To evaluate the effects of endoscopic sinus surgery (ESS) on treatment efficacy, nasal patency, and olfactory function in patients with chronic rhinosinusitis (CRS). Methods: A total of 225 patients with CRS admitted to Tianjin Huanhu Hospital were selected. The control group comprised 100 patients who underwent intranasal maxillary antrostomy, while the observation group included 125 patients who underwent endoscopic sinus surgery. Data were collected from both groups were compared, including treatment efficacy, symptom resolution, nasal patency (nasal minimum cross-sectional area (NMCA), nasal airway resistance (NAR), nasal cavity volume (NCV)), nasal mucociliary function (mucociliary clearance velocity and clearance rate), endoscopic findings (Lund-Kennedy score) and olfactory function, serum inflammatory markers (high-sensitivity C-reactive protein [hs-CRP], tumor necrosis factor α [TNF- α], interleukin-6 [IL-6]), postoperative complications, quality of life using the Chinese version of the Sino-Nasal Outcomes Test 20 [SNOT-20], and short-term recurrence (6-month and 12-month recurrence rates). In addition, the correlation between inflammatory markers and symptom recovery was evaluated. Results: The observation group demonstrated a significantly higher total effective rate, greater improvements in symptom resolution, mucociliary function, endoscopic findings, olfactory function, and quality of life, than the control group. Both groups showed comparable improvement in nasal patency indices. Serum inflammatory markers, the overall complication rate, and 6- and 12-month recurrence rates were significantly lower in the observation group than in the control group. Correlation analysis revealed a significant positive correlation between Δ hs-CRP and olfactory dysfunction ($r = 0.156$, $P = 0.019$), and between Δ IL-6 and nasal obstruction ($r = 0.175$, $P = 0.008$); however, the clinical relevance of these correlations was limited. Conclusion: ESS provides reliable therapeutic benefits for patients with CRS and merits broader clinical adoption.

Keywords: Endoscopic sinus surgery, chronic rhinosinusitis, treatment efficacy, nasal patency, olfactory function

Introduction

Chronic rhinosinusitis (CRS) is an inflammatory disease of the upper respiratory tract that affects individuals of all ages, impairing quality of life and imposing economic burdens on families [1, 2]. The primary pathologic feature is persistent inflammation of paranasal sinus mucosa lasting over 12 weeks, leading to typical clinical manifestations such as nasal obstruction, diminished sense of smell, and pain in the head and face [3]. The global prevalence of CRS is estimated at 8.7%, with rates in Asia ranging from 2.1% to 28.4% [4, 5]. Treatment goals include symptom relief, mucus clearance,

and improvement of nasal patency and mucociliary function [6]. Current first-line therapies include nasal saline irrigation and intranasal corticosteroids; however, a portion of patients who do not respond to these treatments require surgical intervention [7]. While traditional surgical techniques effectively remove lesions and alleviate symptoms, they are associated with significant intraoperative trauma that may compromise nasal mucociliary function and olfactory function, leading to complications and delayed recovery [8]. Endoscopic sinus surgery (ESS), however, uses a nasal endoscope to remove irreversible lesions from the middle turbinate, middle meatus polyps, maxillary sinus

ostium, and sinus cavities. During the procedure, efforts are made to preserve normal mucosa and reversible lesions [9]. A systematic review indicated that this surgery improves sleep quality in patients with CRS by enhancing nasal airflow [10]. Although ESS achieves symptom resolution and helps prevent recurrence and reoperation, some studies have raised concerns about potential long-term mucosal dysfunction [11].

Current research on the comprehensive clinical advantages of ESS for patients with CRS remains incomplete. This study aimed to further characterize the clinical benefits of ESS in this population, providing additional evidence to guide clinical management.

Materials and methods

General data

From December 2021 to December 2025, 225 patients with CRS admitted to Tianjin Huanhu Hospital were enrolled. Patients in the control group (n = 100) underwent intranasal maxillary antrostomy, and those in the observation group (n = 125) underwent endoscopic sinus surgical intervention. No significant inter-group differences were observed in baseline characteristics ($P > 0.05$), indicating comparability between the two groups. For this study, the sample size was estimated as:

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \times [p_1(1 - p_1) + \frac{p_2(1 - p_2)}{k}]}{(p_2 - p_1)^2}$$

Based on a significance level (α) of 0.05 and a power ($1-\beta$) of 0.80, 76 cases per group were required; allowing for a 20% dropout rate, 95 cases per group were needed. As a result, 100 patients were enrolled in the control group and 125 in the observation group, meeting the minimum sample size requirement. This study has been approved by the Tianjin Huanhu Hospital Ethics Committee.

Inclusion and exclusion criteria

Inclusion criteria: Diagnosed with CRS [12]; indicated for the surgery; aged 18-80 years; had not used systemic corticosteroids or immunosuppressants within 3 months prior to surgery; with complete clinical data.

Exclusion criteria: Complicated by other nasal disorders; with asthma, allergic diseases, or fungal sinusitis; with cardiac, pulmonary, or renal impairment; with malignant tumors; with infectious or immune system disorders; with coagulation abnormalities; with a history of sinus or nasal polyp surgery; with severe nasal anatomical deformities; with allergies to study medications; lactating or pregnant women; or with psychiatric conditions preventing normal communication.

Surgical method

In the control group, intranasal maxillary antrostomy was performed. Patients were placed in the supine position and received general anesthesia with endotracheal intubation. An incision was made at the maxillary sinus ostium to fully expose the inferior nasal meatus. A window (approximately 1 cm²) was then created at a suitable location on the medial wall of the maxillary sinus, followed by complete resection of the affected nasal mucosa and polyps. Postoperative management: The surgical cavity was thoroughly rinsed with 0.9% sodium chloride solution. The nasal cavity was packed with hemostatic gauze and gelatin sponge, and the packing was removed 12-24 hours postoperatively. Corticosteroids and antibiotics were used routinely for 1-2 days, and daily nasal irrigation with dexamethasone and gentamicin in saline was performed. Postoperatively, budesonide nasal spray (2 sprays per nostril, twice daily), was administered for 1-3 months.

In the observation group, ESS was performed. Patients were placed in the supine position and received general anesthesia with endotracheal intubation. Nasal mucosa was first decongested using epinephrine in normal saline to fully expose the nasal cavity and lateral wall structures. Under endoscopic guidance, the middle turbinate and middle meatus polyps were excised, and total or partial middle turbinectomy was performed depending on the extent of pathology and drainage requirements. Subsequently, the uncinate process and ethmoid bullae were sequentially resected, followed by opening of the anterior and posterior ethmoid sinuses. The maxillary sinus ostium was properly enlarged, and irreversible lesions within the maxillary sinus ostium and cavity were thoroughly cleared. Intraoperative care was taken

to preserve normal mucosa and reversible lesions. Patients with concomitant nasal septal deviation underwent simultaneous septoplasty, those with turbinate hypertrophy received turbinoplasty, and those with inferior turbinate hypertrophy received partial inferior turbinate resection. Postoperative management was identical to that of the control group.

Outcome measures

Efficacy [13]. Cured: complete resolution of symptoms (e.g., headache, nasal obstruction); normal sinus mucosa on nasal endoscopy; complete disappearance of purulent discharges; blood eosinophil count < 150 cells/ μ L; serum total immunoglobulin (Ig) E < 100 IU/mL; and SNOT-20 score $\leq$ 10. Effective: improvement in symptoms (e.g., headache, nasal obstruction); partial thickening and redness of sinus mucosa on endoscopy; largely resolved purulent discharges, $\geq$ 50% decrease in blood eosinophil count from preoperative levels; and $\geq$ 50% decrease in SNOT-20 score from preoperative scores. Ineffective: no improvement or worsening of symptoms (e.g., headache, nasal obstruction); no improvement or worsening of sinus mucosa; persistent purulent discharges on endoscopy; no decrease or an increase in blood eosinophil count; and < 50% decrease in SNOT-20 score from preoperative levels. The total effective rate is the percentage of the sum of cured and effective patients in all cases.

Symptom resolution [14]. Patients self-assessed nasal obstruction, olfactory dysfunction, and headache/facial pain using the Visual Analogue Scale (VAS) (0-10, where 0 indicates no symptoms) before and 1 month after surgery. Higher scores indicated greater symptom severity.

Nasal patency. Nasal cavity volume (NCV) and nasal minimum cross-sectional area (NMCA) were measured using an Eccovision acoustic rhinometer. Nasal airway resistance (NAR) was determined with a PF210 rhinomanometer.

Nasal mucosal ciliary function. Nasal mucociliary function was assessed using the saccharin test. Patients were seated upright, cleared nasal secretions, and breathed calmly. A saccharin particle less than 1 mm in diameter was placed on the surface of the patient's inferior turbinate, and timing was initiated. The patient swallowed once every 30 seconds, and timing

was stopped when the patient first perceived a sweet taste. The ciliary clearance velocity and clearance rate were evaluated based on the time elapsed until the sweet taste was perceived. Mucociliary clearance velocity = Distance from saccharin placement to posterior pharyngeal wall/time to first sweet taste perception. Mucociliary clearance rate = Time from perception to disappearance of sweet taste/Distance from saccharin placement to posterior pharyngeal wall $\times$ 100%.

Endoscopic findings [15]. Lund-Kennedy scores were recorded preoperatively and postoperatively. A double-blinded evaluator assessed polyps, edema, rhinorrhea (discharges), scars, and crust using nasal endoscopy (0-2 points per item, total score of 0-10 points). Higher scores indicate more severe mucosal conditions.

Olfactory function. Olfactory function was assessed using the standard T&T olfactory test. In a well-ventilated environment, odorless filter paper (1 cm at the tip) impregnated with odorants was placed 1-2 cm below the patient's nostril for 2-3 sniffs. There were five types of odorants: skatole, isovaleric acid, phenethyl alcohol, undecalactone, and methylcyclopentanone, each at eight concentration levels. They were tested sequentially from the lowest to the highest concentration, with scores recorded accordingly. Scores range from -2 to 5 points, where higher scores indicate poorer olfactory function.

Serum inflammatory markers. Fasting venous blood (5 mL) was collected before and after surgery. Serum was separated by centrifugation at 3000 min and stored at -80°C for subsequent analysis. The levels of high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor α (TNF- α), and interleukin-6 (IL-6) were measured via enzyme-linked immunosorbent assay (ELISA).

Postoperative complications. The number of adverse events occurring in all patients after intervention, including infection, sinus ostium obstruction, epistaxis, and nasal adhesions, was observed and recorded, and the incidence was calculated.

Quality of life [16]. The quality of life of patients before and after surgery was evaluated using the SNOT-20 questionnaire. The maximum score is 60 points; lower scores indicate a higher quality of life.

Table 1. Comparison of baseline characteristics between the two groups

Factor	Control group (n = 100)	Observation group (n = 125)	χ^2/t	P
Age (years)	38.49 ± 7.43	39.59 ± 8.67	1.007	0.315
Sex (male/female)	60/40	76/49	0.015	0.903
Disease duration (years)	7.52 ± 3.62	7.76 ± 2.97	0.546	0.585
Affected side (unilateral/bilateral)	25/75	34/91	0.139	0.709
Concomitant nasal polyps (absent/present)	41/59	45/80	0.588	0.443
Smoking history (absent/present)	80/20	92/33	1.264	0.261

Table 2. Comparison of Treatment efficacy between the two groups

Factor	Control group (n = 100)	Observation group (n = 125)	χ^2	P
Cured	38 (38.00)	69 (55.20)		
Effective	40 (40.00)	42 (33.60)		
No effect	22 (22.00)	14 (11.20)		
Total effective rate	78 (78.00)	111 (88.80)	4.821	0.028

Short-term recurrence [17]. The 6-month and 12-month recurrence rates after surgery were recorded. Recurrence was defined as endoscopic evidence of polypoid tissue proliferation or abnormal fibrous connective tissue growth in the nasal cavity or paranasal sinuses, accompanied by ≥ 2 of the following symptoms: significant congestion and swelling of the sinus mucosa, extensive adhesions within the sinus cavities, structural narrowing or even obstruction of sinus ostium, with or without purulent discharges; simultaneously, patients must present at least two clinical symptoms such as nasal obstruction, rhinorrhea, and diminished sense of smell, persisting for over one month without spontaneous resolution, necessitating initiation of pharmacologic intervention.

Statistical analysis

Non-normally distributed continuous variables were expressed as median (interquartile range) [M (Q1, Q3)] and evaluated for intergroup differences using the Mann-Whitney U test. Normally distributed continuous variables were expressed as mean $\pm$ Standard Deviation (SD) and compared using the independent-samples t-test for intergroup comparisons and the paired t-test for intragroup comparisons. Categorical variables were presented as number/percentage (n/%), with intergroup comparisons conducted using the χ^2 test. SPSS 26.0 statistical software was applied for data analysis. $P < 0.05$ was considered significant.

Results

Baseline data in the two groups

As shown in **Table 1**, no significant differences were observed between the two groups in baseline characteristics, including age, sex, disease duration,

affected side, presence of nasal polyps, or smoking history ($P > 0.05$).

Efficacy in the two groups

As shown in **Table 2**, the numbers of cured, effective, and ineffective cases were 38, 40, and 22 in the control group, respectively, and 69, 42, and 14 accordingly in the observation group, indicating a significantly higher overall response rate in the observation group ($P = 0.028$).

Symptom resolution in the two groups

Table 3 presents the VAS scores for symptom resolution before and after surgery in both groups. Preoperative VAS scores for nasal obstruction, olfactory dysfunction, and headache/facial pain did not differ significantly between groups ($P > 0.05$). Postoperatively, scores decreased significantly in both groups, with significantly lower scores in the observation group for all symptoms ($P < 0.01$).

Nasal patency in the two groups

Figure 1 shows nasal patency indices (NMCA, NAR, and NCV) in both groups. Baseline values showed no significant differences between groups ($P > 0.05$). Postoperatively, NMCA and NCV increased significantly while NAR decreased significantly in both groups ($P < 0.01$), with no significant intergroup differences ($P > 0.05$).

Table 3. Comparison of symptom resolution between the two groups

Factor	Control group (n = 100)	Observation group (n = 125)	Z	P
Nasal obstruction				
Before surgery	7.00 (6.00, 9.00)	7.00 (4.00, 8.00)	-1.412	0.158
After surgery	3.50 (2.25, 4.75)**	3.00 (2.00, 4.00)**	-2.676	0.007
Olfactory function				
Before surgery	5.00 (4.00, 7.00)	6.00 (4.00, 7.00)	-0.396	0.692
After surgery	3.00 (2.00, 4.75)**	2.00 (1.00, 3.00)**	-4.487	< 0.001
Headache and facial pain				
Before surgery	3.00 (2.00, 3.00)	2.00 (2.00, 3.00)	-1.213	0.225
After surgery	2.00 (1.00, 2.00)**	1.00 (1.00, 1.00)**	-4.848	< 0.001

Note: **P < 0.01 compared to before surgery.

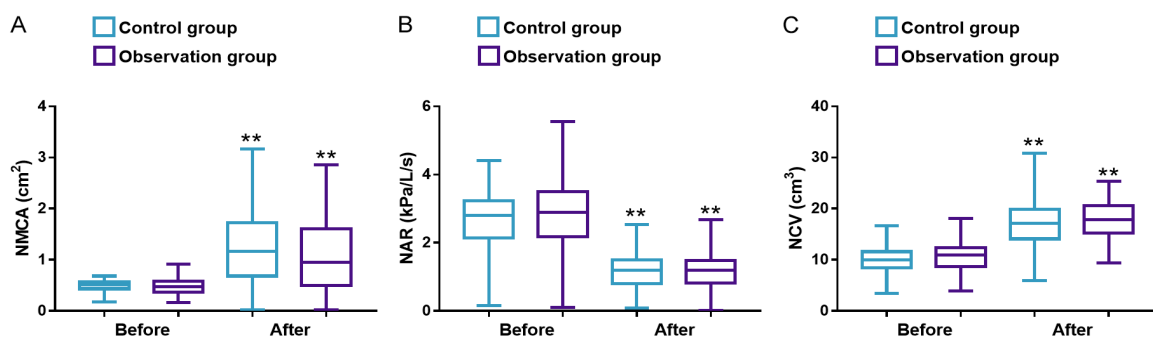


Figure 1. Comparison of nasal patency indices before and after surgery between the two groups. A. NMCA before and after surgery in the two groups. B. NAR before and after surgery in the two groups. C. NCV before and after surgery in the two groups. Note: **P < 0.01 compared to before surgery. NMCA, nasal minimum cross-sectional area; NAR, nasal airway resistance; NCV, nasal cavity volume.

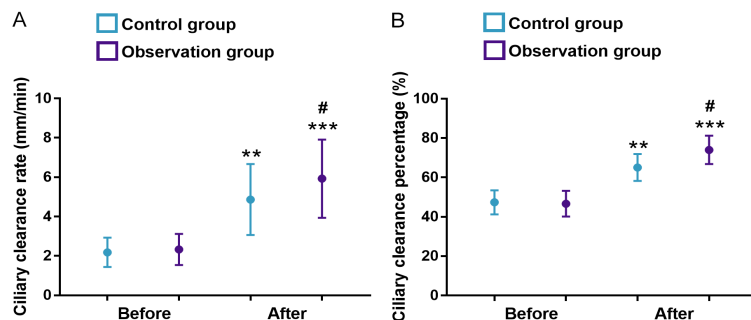


Figure 2. Comparison of nasal mucociliary function before and after surgery between the two groups. A. Mucociliary clearance velocity before and after surgery in the two groups. B. Mucociliary clearance rate before and after surgery in the two groups. Note: **P < 0.01, ***P < 0.001, compared to before surgery; #P < 0.05, compared to the control group.

Nasal mucosal ciliary function in the two groups

Figure 2 presents mucociliary function indices. Baseline values showed no significant differences between groups (P > 0.05). Postoperatively, both clearance velocity and clearance

rate significantly increased in both groups (P < 0.01), with significantly higher values in the observation group (P < 0.05).

Endoscopic findings and olfactory function in the two groups

As presented in **Table 4**, there were no significant differences in preoperative Lund-Kennedy scores or T&T olfactory test scores between the two groups (P > 0.05). Postoperatively, both groups demonstrated notably reduced scores in these

two scales, and the scores were lower in the observation group (P < 0.01).

Serum inflammation in the two groups

Figure 3 presents serum inflammatory markers levels. Baseline levels showed no significant

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Table 4. Comparison of endoscopic findings and olfactory function between the two groups

Factor	Control group (n = 100)	Observation group (n = 125)	Z	P
Lund-Kennedy score				
Before surgery	7.00 (4.25, 8.00)	6.00 (5.00, 8.00)	-0.530	0.596
After surgery	4.00 (3.00, 6.00)**	3.00 (2.00, 4.00)**	-5.151	< 0.001
T&T olfactory test				
Before surgery	4.00 (3.00, 4.75)	4.00 (3.00, 5.00)	-0.242	0.809
After surgery	3.00 (3.00, 4.00)**	3.00 (2.00, 3.00)**	-4.772	< 0.001

Note: **P < 0.01 compared to before surgery.

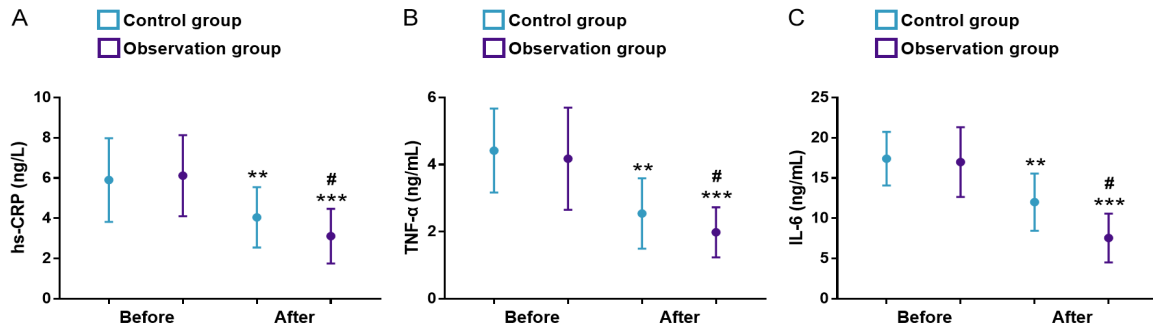


Figure 3. Comparison of Serum inflammatory markers before and after surgery between the two groups. A. hs-CRP before and after surgery in the two groups. B. TNF- α before and after surgery in the two groups. C. IL-6 before and after surgery in the two groups. Notes: **P < 0.01, ***P < 0.001, compared to before surgery; #P < 0.05, compared to the control group. hs-CRP, high-sensitivity C-reactive protein; TNF- α , tumor necrosis factor α ; IL-6, interleukin-6.

Table 5. Correlation between serum inflammatory markers and symptom resolution

Item	r	P
Δ hs-CRP - Nasal obstruction	0.004	0.956
Δ hs-CRP - Olfactory dysfunction	0.156	0.019
Δ hs-CRP - Headache and facial pain	0.076	0.257
Δ TNF- α - Nasal obstruction	0.012	0.863
Δ TNF- α - Olfactory dysfunction	-0.034	0.609
Δ TNF- α - Headache and facial pain	-0.032	0.631
Δ IL-6 - Nasal obstruction	0.175	0.008
Δ IL-6 - Olfactory dysfunction	0.088	0.190
Δ IL-6 - Headache and facial pain	0.004	0.947

Note: hs-CRP, high-sensitivity C-reactive protein; TNF- α , tumor necrosis factor α ; IL-6, interleukin-6.

differences between groups ($P > 0.05$). Post-operatively, hs-CRP, TNF- α , and IL-6 decreased significantly in both groups ($P < 0.01$), with significantly lower levels in the observation group ($P < 0.05$).

Correlation analysis (Table 5) revealed a significant positive correlation between Δ hs-CRP and olfactory dysfunction ($r = 0.156$, $P = 0.019$), and between Δ IL-6 and nasal obstruction ($r = 0.175$, $P = 0.008$). No other significant correlations were observed ($P > 0.05$).

Postoperative complications in the two groups

The incidence of overall post-operative complications, including infection, sinus ostium obstruction, epistaxis, and nasal adhesions, was 14.40% in the observation group, lower than the 33.00% in the control group ($P < 0.001$) (Table 6).

Quality of life in the two groups

Figure 4 presents quality of life assessed by the SNOT-20 questionnaire. No significant difference was observed in baseline SNOT-20 scores between the two groups ($P > 0.05$). Postoperative SNOT-20 scores decreased significantly in both groups ($P < 0.01$), with significantly lower scores in the observation group ($P < 0.05$).

Short-term recurrence in the two groups

As shown in Table 7, both the 6-month and 12-month recurrence rates were substantially lower in the observation group ($P < 0.01$).

Table 6. Comparison of Postoperative complications between the two groups

Factor	Control group (n = 100)	Observation group (n = 125)	χ^2	P
Infection	8 (8.00)	4 (3.20)		
Sinus ostium obstruction	10 (10.00)	6 (4.80)		
Epistaxis	7 (7.00)	3 (2.40)		
Nasal adhesions	8 (8.00)	5 (4.00)		
Total	33 (33.00)	18 (14.40)	10.965	< 0.001

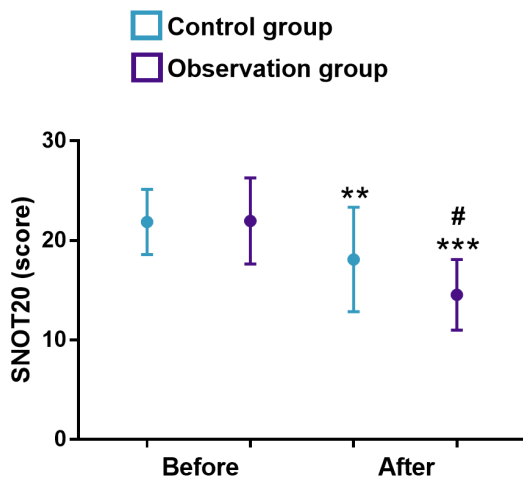


Figure 4. Comparison of quality-of-life scores before and after surgery between the two groups. Notes: **P < 0.01, ***P < 0.001, compared to before surgery; #P < 0.05, compared to the control group. SNOT-20, Sino-Nasal Outcomes Test 20.

Discussion

This study demonstrated that ESS was associated with significantly higher efficacy in treating CRS, effectively alleviating symptoms, restoring sinus mucosa, and eliminating purulent secretions. ESS may overcome the limited surgical field associated with intranasal maxillary antrostomy, allowing for precise localization and effective removal of diseased tissue. Furthermore, the endoscope's compact size minimizes mucosal damage during the procedure, facilitating faster recovery. Second, ESS provided more effective relief from nasal obstruction, olfactory dysfunction, and headache/facial pain, further confirming its clinical advantages. Nasal patency analysis revealed that ESS restored nasal airflow to a degree comparable to that achieved with intranasal maxillary antrostomy. This may be attributed to the clear surgical field provided by ESS, which enables precise assessment of lesion severity and extent, facilitating accurate resection of

diseased mucosa and polyps. Consequently, it effectively resolves obstruction in the nasal passages and sinuses, ensuring airway patency. Consistent with our findings, Ma et al. [18] reported that ESS further improved the overall response rate and nasal patency in patients with CRS and nasal polyps.

In patients with CRS, ESS significantly improved mucociliary clearance velocity and rate, leading to effective restoration of nasal mucociliary function. We also observed that ESS effectively improved mucosal condition and olfactory function. This may be attributed to the procedure's ability to remove irreversible lesions effectively at the maxillary sinus ostium and within the sinus cavity. By preserving normal mucosa and reversible lesions, the procedure maintains mucosal function and promotes recovery. This, in turn, enhances mucociliary clearance and aids in the recovery of olfactory function. Jiang et al. [19] reported that ESS significantly increased olfactory bulb volume in patients with CRS, which may explain its mechanism for olfactory recovery. Boscolo-Rizzo et al. [20] also reported positive effects of ESS on olfactory function in CRS patients, consistent with our findings. We also found that ESS was more effective in improving abnormal serum inflammatory marker levels in CRS patients. This may be attributed to ESS's ability to relieve sinus obstruction, remove diseased mucosa, and reduce the inflammatory burden, thereby decreasing local and systemic inflammation. Furthermore, correlation analysis revealed a significant positive correlation between Δ hs-CRP and olfactory dysfunction and between Δ IL-6 and nasal obstruction; however, the correlation coefficients were very low (0.156 and 0.175, respectively), suggesting limited clinical significance despite statistical significance. Regarding safety, ESS effectively reduced postoperative complications, including infection, ostium obstruction, epistaxis, and nasal adhesions. This may be due to reduced discharge

Table 7. Comparison of Short-term recurrence rates between the two groups

Factor	Control group (n = 100)	Observation group (n = 125)	χ^2	P
6-month recurrence rate	14 (14.00)	5 (4.00)	7.186	0.007
12-month recurrence rate	18 (18.00)	7 (5.60)	8.649	0.003

retention and improved wound healing following ESS. The SNOT-20 assessment revealed that ESS significantly improved patient quality of life. Similarly, Smith et al. [21] demonstrated significant improvements in quality of life at 6 months after ESS in CRS patients. Finally, short-term outcome assessments revealed that ESS effectively reduced 6-month and 12-month recurrence rates in CRS patients. Wang et al. [15] reported that in patients with eosinophilic CRS and nasal polyps, ESS alleviated nasal symptoms, restored olfactory function, and reduced recurrence risk at 12-25 months, similar to our findings. Furthermore, Yim et al. [22] reported that ESS was more cost-effective than continuous medical therapy in CRS patients, particularly in refractory cases.

The novelty of this study included: (1) confirmation that ESS is significantly superior to intranasal maxillary antrostomy for treating CRS; (2) multi-dimensional evaluation of ESS's clinical advantages, covering symptom resolution, nasal patency, mucociliary function, endoscopic findings, olfactory function, and serum inflammatory markers; and (3) clarification of ESS's benefits in terms of complications, quality of life, and short-term recurrence.

This study also had several limitations. First, the intranasal maxillary antrostomy, used in the control group, is no longer a mainstream technique in most medical centers; the differences in invasiveness and precision between the two procedures may influence clinical comparability. Therefore, our conclusions are primarily applicable to settings transitioning from traditional to endoscopic techniques. Second, although significant decreases in hs-CRP, TNF- α , and IL-6 were observed after ESS, there is no unified minimum clinically important difference (MCID) for these markers in the literature, making it difficult to quantitatively assess their clinical value. Future studies could incorporate patient-reported outcome measures with established MCIDs, such as the SNOT-22, to indirectly estimate clinically relevant thresholds for inflammatory markers through combined

analysis. Finally, this was a single-center retrospective study with a limited sample size. Large-scale multi-center prospective studies are needed to enhance the generalizability of our findings.

In summary, ESS demonstrates superior efficacy to intranasal maxillary antrostomy for treating CRS. It significantly alleviates symptoms, restores nasal airflow, enhances mucociliary function, improves mucosal and olfactory function, and suppresses serum inflammatory markers, with a favorable safety profile. ESS also improves quality of life and reduces short-term recurrence rates.

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Disclosure of conflict of interest

None.

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