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Clinical Analysis of Modified Extended Endoscopic Sinus Surgery for Chronic Rhinosinusitis with Nasal Polyps and Allergic Rhinitis

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ABSTRACT

Extended endoscopic sinus surgery (EESS) can reduce the recurrence rate of chronic rhinosinusitis (CRS). The purpose of this study was to investigate the effect of the application of modified "protective middle turbinate-EESS" (mEESS) on patients with CRS with nasal polyps (CRSwNP) and allergic rhinitis (AR).

Forty-three patients with CRSwNP and AR were classified into 2 groups, the mEESS group (n=23) and the functional endoscopic sinus surgery (FESS) group (n=20), and were followed up for 6 months and 1 year after surgery. The disease severity was assessed by the Lund-Mackay score, the Lund-Kennedy score, and the visual analog scale (VAS) score. The patency rate of the frontal sinus was evaluated by endoscopy. Patient satisfaction was also followed up.

No preoperative differences or postoperative complications were found between the 2 groups. The VAS score and Lund-Kennedy score of the 2 groups were lower at 6 months and 1 year after surgery. The olfactory function of the mEESS group was significantly better than that of the FESS group at 6 months post-operative. The patency rate of the frontal sinus orifice in the mEESS group was significantly higher than that in the FESS group at 6 months and 1 year post-operative. Patient satisfaction in the mEESS group was relatively higher than that in the FESS group.

mEESS improves frontal sinus drainage, olfactory sense, and patient satisfaction in the short term.

Keywords: Allergic rhinitis; Chronic rhinosinusitis; Endoscopic sinus surgery; Extended frontal sinusotomy; Olfaction

INTRODUCTION

Chronic rhinosinusitis (CRS) is a chronic inflammatory disease of the paranasal sinuses that lasts for over 12 weeks. It is normally classified into 2 categories: CRS with nasal polyps (CRSwNP) and CRS without nasal polyps (CRSsNP).[1,2] Despite standard treatment that includes medicine and functional endoscopic sinus surgery (FESS), more than 10% of patients still complain of recurrence of nasal symptoms such as nasal congestion, sticky purulent nasal secretion, vesicles, and reformation of nasal polyps. This is termed

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refractory rhinosinusitis (RRS).[1] Given that an allergic reaction may contribute to the pathogenesis of CRS, inflammatory or aggravating factors are also probably involved in the transformation of CRS into RRS.[3] Based on the above predisposition, current research is focused on patients' satisfaction and quality of life.

Based on FESS, a modified surgery termed extended endoscopic sinus surgery (EESS) is used to treat patients with RRS.[4] In this surgery, the middle turbinate is partially or totally removed, which opens up the paranasal sinuses as much as possible. Frontal sinus lesions in patients with refractory CRS are quite severe, and the recurrence rate of sinus atresia is high after endoscopic sinus surgery;[5] hence, the changeable patency of the frontal sinus drainage surgery has received considerable attention. Some studies followed patients who underwent Draf III surgery, Draf IIb surgery, and their modified surgery[6–8] and found that the patency of the frontal sinus was significantly improved. Patients who underwent Draf IIb surgery showed a similar patency rate, symptom improvement rate, and quality of life as those who underwent Draf III surgery.[9,10] Some scholars believe that the stump of the middle turbinate can lead to frontal recess stenosis and frontal sinusitis.[11] An excessively excised middle turbinate increases the risk of atrophic rhinitis and facilitates the deterioration of intraoperative markers.[12] Previous studies have shown that up to 84% of patients with CRS have olfactory disorders.[13] Middle turbinectomy may damage olfactory nerve fibers and lead to olfactory disorders.

To highlight preserving the middle turbinate during surgery as much as possible while removing a part of the middle turbinate affecting the frontal recess and keeping the frontal sinus drainage unobstructed, we further improved EESS and proposed "protective middle turbinate-EESS" (mEESS), which involves the bridge type preservation of the middle turbinate, opening of the frontal sinus by Draf IIb surgery, total ethmoidectomy, removal of the superior turbinate, and enlargement of the orifice of the sphenoid sinus and the maxillary sinus as much as possible.

Previous studies have shown that EESS lowers the risk of recurrence and modifies the operation rate of patients with CRSwNP.[14,15] However, it remains unclear whether EESS can improve the prognosis of patients with CRSwNP and AR. In the present study, our primary objective was to investigate the effect of mEESS on draining the frontal sinus so as to improve the olfactory function of patients with CRSwNP and AR and thus emphasize the suitability of the extensive application of this technique.

MATERIALS AND METHODS

Clinical Data

The present study included 43 patients with CRSwNP and AR who had undergone surgery in the First Affiliated Hospital of Chongqing Medical University, Chongqing, China, from January 2017 to December 2018; of these patients, 23 were included in the mEESS group, and the remaining patients were in the FESS group. All surgeries were performed by senior specialists in the ear, nose, and throat (ENT) Division under general anesthesia after the patients signed an informed consent form. The study received approval from the Medical Ethics Committee of the hospital.

The diagnostic criteria were as follows: patients were diagnosed with CRSwNP according to the "European Position Paper on Rhinosinusitis and Nasal Polyps 2012 (EPOS2012)"[1] and the "Guidelines for diagnosis and treatment of chronic rhinosinusitis".[2] The diagnosis of AR was made according to the Chinese guidelines for the diagnosis and treatment of AR.[16] The inclusion criteria were as follows: (1) patients with CRSwNP (bilateral) and long-term AR; (2) patients who had received proper treatment (medication and/or operation) for at least 3 months without satisfactory results; and (3) patients were aged ≥18 years. The exclusion criteria were as follows: patients with NSAID Exacerbated Respiratory Disease, immunodeficiency, bronchiectasis, upper respiratory tract infection in the past 1 month, asthma attack, chronic obstructive pulmonary disease, diabetes, tumor, fungal sinusitis, pregnancy, or lactation.

Surgical Methods

All patients were operated by senior ENT surgeons under general anesthesia. The scope of the operation depended on computed tomography (CT) findings and intraoperative judgment. Patients with a high arch of the inferior turbinate were treated with an external displacement of the turbinate fracture and possibly nasal septoplasty if they had a deviation of the nasal septum. The middle nasal meatus was filled with nasoabsorbable cotton after the lesion was completely removed. If nasal septoplasty was performed, every nasal cavity was filled with an expansion sponge.

In the mEESS group, the surgeon first excised nasal polyps and then performed radical ethmoidectomy, i.e.,

removing the anterior wall of the sphenoid sinus to increase the cavity space, to bridge both the sphenoid sinus and the posterior ethmoid sinus. The maxillary sinus was opened through the natural ostium and fused with the posterior ethmoid sinus. After exploring the natural orifice of the frontal sinus, the surgeon cut the air chamber of the frontal recess orifice and ground the anterior wall bone. The anterior wall of the middle turbinate was dissected to enlarge the space between the frontal sinus and the septum. The polypoid mucosa was cut, and the tail of the middle turbinate was retained. The top wall of the nasal cavity was linked with the upper and posterior part of the middle turbinate like 2 piers–sphenoid sinus hands with the posterior ethmoid sinus under the "bridge." Consequently, all nasal sinuses were opened up to maximize ventilation and drainage after surgery while preserving the middle and inferior turbinate during surgery. Only irreversible lesions, such as polyps and severe polypoid mucous membranes, were resected.

The procedure was performed using the Messerklinger technique in the FESS group. Nasal polyps should be removed first, and then, if needed, the paranasal sinus should be operated.

Postoperative Management

Two days after surgery, the expansion sponge was removed, and nasal endoscopy was performed to assess the lesion the next day. Mometasone furoate nasal spray was administered once a day, with 2 sprays for each nostril. Oratadine tablets (Clarityne) and montelukast sodium tablets (Singulair) were prescribed before sleep for 2 weeks after discharge. Normal saline irrigation twice a day for 3 months was recommended. Nasal endoscopic examination or dressing change was performed 2 weeks after discharge, 6 weeks after discharge, 3 months after the operation, 6 months after the operation, and 1 year after the operation, and the medication was adjusted according to the symptoms and operating cavity.

Evaluation Method

(1) The patients were assessed for overall discomfort and local symptoms (nasal congestion, mucopurulent discharge, headache and/or facial pain, decreased sense of smell, nasal itching, and sneezing) with the CRS Visual Analog Scale (VAS) (scores range from 0 to 10, 0 for "asymptomatic" and 10 for "most severe"). Trained otorhinolaryngologists instructed patients to quantify nasal symptoms into matching scores. VAS scores were reported during face-to-face or telephone follow-up before the operation, 6 months after the operation, and 1 year after the operation.

(2) Objective evaluation: The preoperative CT images were subjected to scoring with the Lund-Mackay (L-M) method, and the endoscopic examination results were scored with the Lund-Kennedy (L-K) method before the operation, 6 months after the operation, and 1 year after the operation.

(3) Satisfaction rate: As satisfaction is highly subjective, we prepared a questionnaire to obtain subjective feelings about the surgery 1 year postoperatively. The questionnaire was based on the survey on the satisfaction of patients with chronic sinusitis by Mattos et al.[17]

(4) The patency of the frontal sinus was followed for 6 months and 1 year after the operation. The evaluation criteria were as follows: under a nasal endoscope, a maximum diameter of the frontal sinus orifice ≥5 mm was indicative of patency,<5 mm was considered frontal sinus orifice stenosis, and no opening was considered frontal sinus atresia.[8]

(5) Long-term and short-term complications were evaluated after surgery.

Statistical Analysis

Changeable VAS scores, patient satisfaction before and after surgery, and demographic data were analyzed by SPSS version 25.0. The normally distributed measurement data were examined by *t* test and expressed by $\bar{x} \pm s$. The nonnormally distributed measurement data were examined by the Mann–Whitney U test and expressed as the median (interquartile range). The qualitative data were examined by the χ^2 test and expressed as percentages. The difference was considered to be statistically significant if the p value<0.05.

RESULTS

Preoperative Evaluation

Both groups showed similar characteristics in terms of age, sex, sinusitis operation, and smoking history in the *t* test and χ^2 test (p>0.05). The VAS, L-M, and L-K scores of the 2 groups did not follow a normal distribution, and there was no significant difference between the 2 groups as determined by the Mann–Whitney U test (p>0.05). The demographic and preoperative evaluation results of the 2 groups are shown in Table 1.

Table 1. Demographic and preoperative evaluation results of the 2 groups

Parameters	mEESS Group (n=23)	FESS Group (n=20)	*p*
Age	48.25±10.45	46.65±10.20	0.613
Sex (male/female)	14/9	17/3	0.099
Surgical history of sinusitis(yes/no)	12/11	6/14	0.216
Smoking (yes/no)	11/12	7/13	0.093
Asthma (yes/no)	5/18	5/15	1.000
VAS score			
General	7 (2)	7 (3)	0.434
Nasal congestion	7 (3)	6 (4)	0.416
Discharge	5 (7)	4.5 (3.75)	0.648
Headache and/or facial pain	2 (5)	1 (3.75)	0.531
Decrease sense of smell	9 (2)	8.5 (2.75)	0.847
Nasal itching	1 (3)	1.5 (2.75)	0.601
Sneeze	2 (2)	6 (3)	0.367
L-M score	22 (3)	21 (11)	0.730
L-K score	10 (0)	8.5 (2)	0.062

Age was expressed as $\bar{x} \pm s$ and the independent *t* test was used for statistical analysis. Statistical analysis of sex, surgical history, smoking, and asthma ratio was performed using $\chi 2$ test. The VAS, L-M, and L-K scores were expressed as median (interquartile range), and the Mann–Whitney U test was used for statistical analysis. VAS: visual analog scale; L-M: Lund-Mackay; L-K: Lund-Kennedy.

Postoperative Evaluation

Comparison of the VAS of Overall Discomfort and Symptoms and L-K Scores Between the 2 Groups Before The Operation, 6 Months after Operation, and 1 Year after Operation

Except that the olfactory function of the observation group was better than that of the FESS group 6 months after the operation (p=0.047), there was no significant difference in the VAS or L-K scores before the operation, 6 months after surgery, and 1 year after surgery. The L-K and VAS scores of the 2 groups before the operation, 6 months after the operation, and 1 year after the operation are shown in Figure 1.

Comparison of VAS of Symptoms and L-K Scores Before Operation, 6 Months after Operation, and 1 Year after Operation in the 2 Groups

All VAS and L-K scores were better at 6 months and 1 year after the operation. Regarding the VAS score, the improvement in olfactory function at 6 months after surgery was more significant than that at 1 year after surgery (p<0.05), while the other VAS and L-K scores were not statistically significant (p>0.05). The VAS and L-K scores of overall discomfort and symptoms before the operation, 6 months after operation, and 1 year after operation in the mEESS group are shown in Table 2, while those in the FESS group are shown in Table 3.

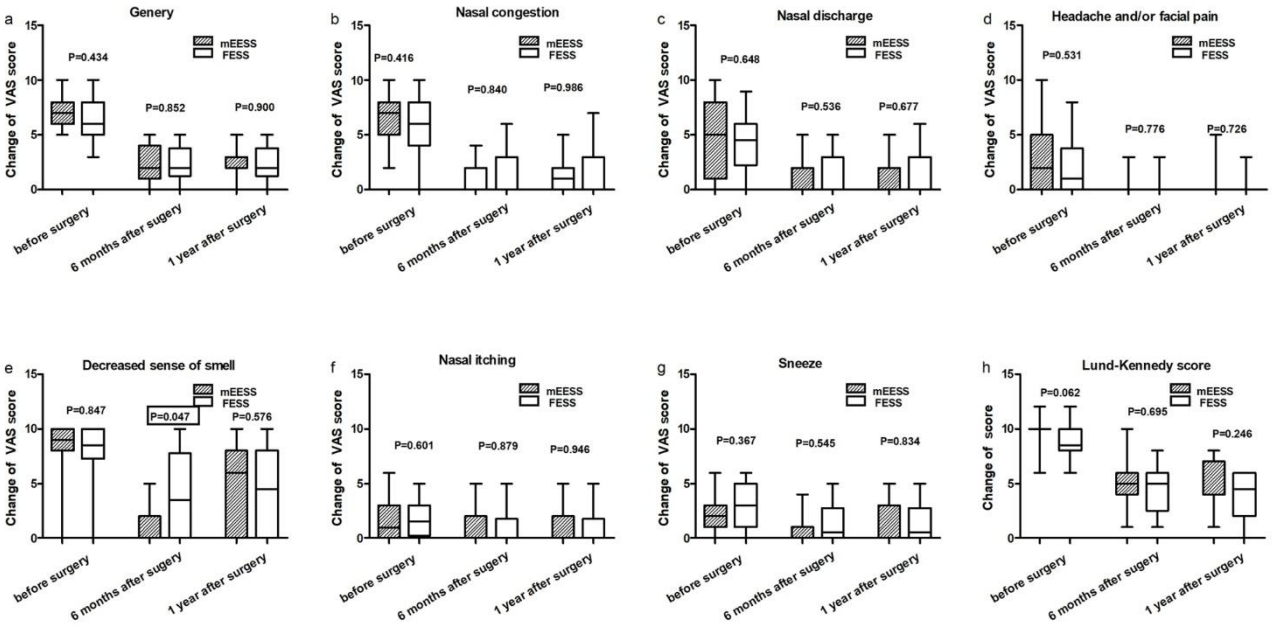

Figure 1. Comparison of the visual analog scale (VAS) scores of various symptoms between the 2 groups before and after surgery. (a) VAS score of general condition; (b) VAS score of nasal obstruction; (c) VAS score of nasal discharge; (d) VAS score of headache and/or facial pain; (e) VAS score of decreased sense of smell; (f) VAS score of nasal itching; (g) VAS score of sneezing; (h) Lund-Kennedy (L-K) score.

Table 2. Comparison of VAS and L-K scores of the mEESS group before surgery, 6 months after surgery and 1 year after surgery

Symptoms	Before Surgery	6 Months after Surgery	1 Year after Surgery	*p*1	*p*2	*p*3
General	7 (2)	2 (3)	2 (1)	<0.001	<0.001	0.414
Nasal congestion	7 (3)	0 (2)	1 (2)	<0.001	<0.001	0.458
Discharge	5 (7)	0 (2)	0 (2)	0.001	0.001	0.180
Headache and/or facial pain	2 (5)	0 (0)	0 (0)	<0.001	<0.001	0.317
Decreased sense of smell	9 (2)	2 (2)	6 (8)	0.001	<0.001	<0.001
Nasal itching	1 (3)	0 (2)	0 (2)	0.034	0.031	0.317
Sneeze	2 (2)	0 (1)	0 (3)	<0.001	<0.001	0.051
L-K score	10 (0)	5 (2)	4 (3)	<0.001	<0.001	0.840

The score is expressed by the median (quartile distance). ***p*** 1, ***p*** 2, and ***p*** 3 represent the comparison between postoperative 6 months and preoperative, postoperative 1 year and preoperative, and postoperative 1 year and postoperative 6 months in the mEESS group, respectively. VAS: visual analog scale; L-K: Lund-Kennedy; mEESS: modified extended endoscopic sinus surgery.

Table 3. Comparison of VAS and L-K scores of the FESS group before surgery, 6 months after surgery, and 1 year after surgery

Symptoms	Before Surgery	6 Months after Surgery	1 Year after Surgery	*p*1	*p*2	*p*3
General	7 (3)	2 (0.5)	2 (2.5)	<0.001	<0.001	0.257
Nasal congestion	6 (4)	0 (3)	0 (3)	<0.001	<0.001	0.334
Discharge	4.5 (3.75)	0 (3)	0 (3)	<0.001	<0.001	0.785
Headache and/or facial pain	1 (3.75)	0 (0)	0 (0)	0.001	0.001	0.317
Decreased sense of smell	8.5 (2.75)	3.5 (7.75)	4.5 (8)	<0.001	<0.001	<0.001
Nasal itching	1.5 (2.75)	0 (1.75)	0 (1.75)	0.001	0.001	0.317
Sneeze	6 (3)	0 (2)	0.5 (2.75)	0.004	0.001	0.066
L-K score	8.5 (2)	5 (3.5)	4.5 (4)	<0.001	<0.001	0.199

The score is expressed by the median (quartile distance). *p*1, *p*2, and *p*3 represent the comparison between postoperative 6 months and preoperative, postoperative 1 year and preoperative, and postoperative 1 year and postoperative 6 months in the FESS group, respectively. VAS: visual analog scale; L-K: Lund-Kennedy; FESS: functional endoscopic sinus surgery.

Comparison of the Rate of Patency of the Frontal Sinus at 6 Months and 1 Year after Operation

The bilateral frontal sinuses were opened in both the mEESS and FESS groups, and 46 and 40 frontal sinuses were operated, respectively. According to the χ^2 test, the patency rate of the frontal sinus in the mEESS group was higher than that in the FESS group at 6 months after operation (p=0.003, χ^2=8.945). The patency rate of the frontal sinus in the mEESS group was also higher than that in the FESS group at 1 year after operation (p=0.001, χ^2=10.860). Tables 4 and 5 show the comparison of the proportion of open frontal sinus at 6 months and 1 year after operation in the two groups. The status of the mEESS group during operation and 1 year after operation is shown in Figure 2.

Comparison of Satisfaction at 1 Year after Operation

The satisfaction rates in the mEESS and FESS groups were 82.6% and 50%, respectively. According to the χ^2 test, postoperative satisfaction was higher in the mEESS group than in the FESS group (p=0.048, χ^2=5.180). The satisfaction rates of the patients in both groups are shown in Table 6.

Complications

There were no postoperative complications in any of the patients after discharge.

Table 4. Comparison of frontal sinus patency 6 months after the operation (number)

Group	Unobstructed	Narrow	Lock-up	Patency Rate	*p*	χ^2
mEESS	42	4	0	91.3%	0.003	8.945
FESS	26	12	2	65.0%		

Statistical analysis of the frontal sinus patency rate was performed using χ^2 test. mEESS: modified extended endoscopic sinus surgery; FESS: functional endoscopic sinus surgery.

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Table 5. Comparison of frontal sinus patency 1 year after the operation (number)

Group	Unobstructed	Narrow	Lock-up	Patency Rate	*p*	χ^2
mEESS	40	6	0	87.0%	0.001	10.860
FESS	22	15	3	55.0%		

Statistical analysis of the rate of frontal sinus patency was performed using χ^2 test. mEESS: modified extended endoscopic sinus surgery; FESS: functional endoscopic sinus surgery.

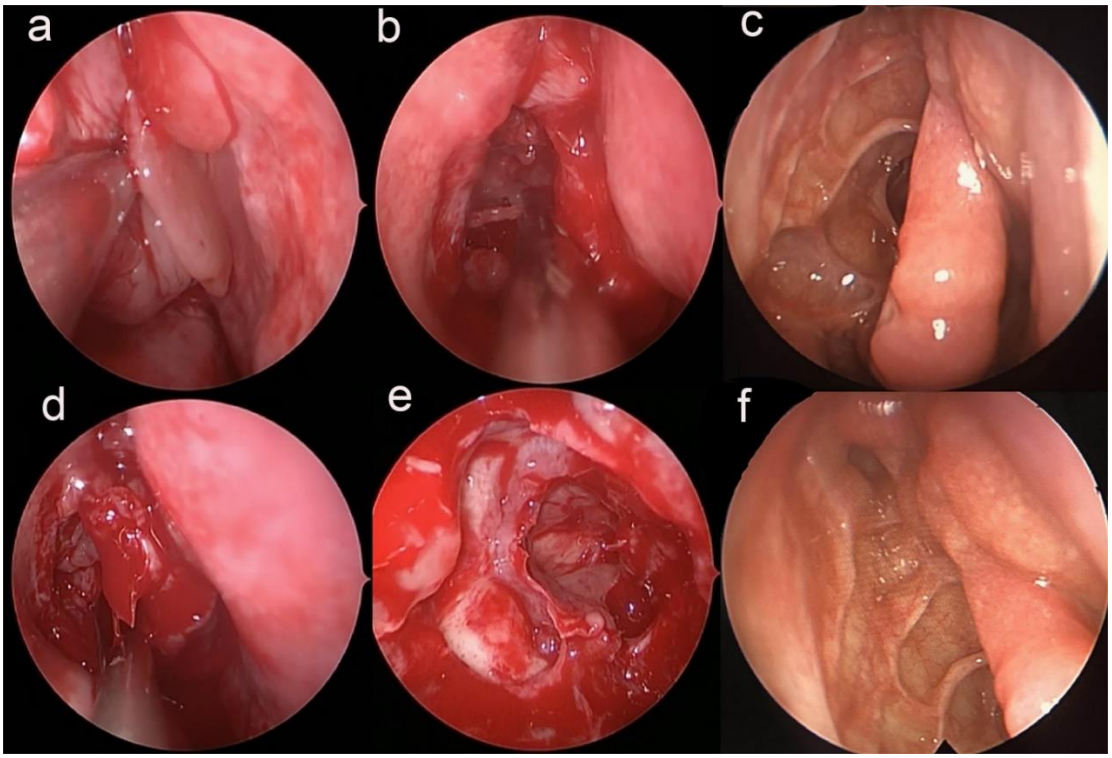

Figure 2. Intraoperative and postoperative 1-year outcome in the modified extended endoscopic sinus surgery (mEESS) group. (a) Multiple nasal polyps and mucosal edema were observed during the operation; (b) Resection of nasal polyps during operation; (c) Open ethmoid sinus during operation; (d) During operation, the entire group of sinuses was opened up wider to make the sinuses integrated; (e) The middle turbinate preserved by the "bridge" was observed under 0-degree endoscopy 1 year after operation, with smooth mucosa, good opening of each sinus cavity, and no obvious adhesion; (f) An open frontal sinus orifice (Draf IIb) was observed under nasal 30-degree endoscopy 1 year after operation.

Table 6. Satisfaction rate of the patients in the mEESS and FESS groups (cases)

Group	Satisfied	General	Dissatisfaction Rate	Satisfaction Rate	*p*	$\chi 2$
mEESS	19	4	0	82.6%	0.048	5.180
FESS	10	10	0	50%		

Statistical analysis of the satisfaction rate was performed using $\chi 2$ test. mEESS: modified extended endoscopic sinus surgery; FESS: functional endoscopic sinus surgery.

DISCUSSION

Surgical treatment and appropriate medication can greatly improve the nasal symptoms of patients with CRS. Patients with a predisposition to allergies are also more inclined to have a poor prognosis and relapse after surgery.[18,19] Some studies have shown that EESS is more feasible for patients with asthma, allergies, and ciliary dysfunction.[4] In this study, the improvement in olfactory perception and frontal sinus drainage in the modified "bridge" EESS group with middle turbinate preservation was more statistically significant, and the satisfaction rate was higher.

The issue of middle turbinate preservation remains to be fully clarified. Scholars who support the preservation of the middle turbinate believe that injury to the middle turbinate may cause changes in nasal airflow, humidification, sense of smell, and nasal immune function and increase the risks of atrophic rhinitis, anosmia, and destruction of intraoperative markers.[11,20] Surgeons who support middle turbinectomy believe that it can reduce the incidence of postoperative adhesion formation, improve the patency of the sinus outflow tract, enable better display of the paranasal sinuses during and after operation, and improve ventilation in the olfactory area.[21,22] Endoscopic partial middle-turbinectomy improves CRS symptoms and the quality of life of patients.[23] Conventional sinus surgery only opens the ostium and cannot reduce the eosinophilic inflammatory burden, however, extensive surgical approaches help to ameliorate inflammation.[24] In this study, the modified EESS helped to preserve the middle and lower turbinates as much as possible, as an extensive surgical approach, maintained nasal physiological function, ensured adequate ventilation space, and facilitated good sinus drainage.

It has long been recognized that FESS is difficult to treat inflammatory frontal sinus disease. This is largely due to the difficulty in delivering topical medication to the frontal sinus postoperatively, thereby contributing to stenosis of the sinusotomy and recurrence of the disease.[24] If the middle turbinate is partially removed during Draf I or Draf IIa surgery or during ethmoidectomy, the remaining middle turbinate may adhere to the medial orbital wall, resulting in stenosis or occlusion of the frontal sinus orifice, which may also be the cause of iatrogenic frontal sinusitis.[11] However, in a review by Choby et al[25] 2 case studies on FESS were reviewed to evaluate frontal sinusitis or stenosis after partial middle turbinectomy and middle turbinate preservation, and there was no significant difference in the incidence of frontal sinusitis or stenosis between the 2 groups. Steven et al[26] showed that during the study period, the incidence of frontal sinus atresia in both partial and complete middle turbinectomy groups was 0%. In our study, we present an improved EESS procedure in which part of the middle turbinate affecting the frontal recess was removed while most of the middle turbinate was able to be retained. The results showed that the rate of frontal sinus orifice patency was higher in the mEESS group. However, stenosis and atresia of the frontal sinus orifice are still worthy of attention. After many operations, the frontal sinus becomes bony due to the removal of the mucous membrane, resulting in frontal sinus drainage channel stenosis. Fiorini et al[27] used a nasal septum valve in patients who underwent Draf IIb surgery, and 43 patients (93.5%) showed a good prognosis. Perhaps we can further improve the application of the nasal septum valve to ensure better frontal sinus drainage.

The etiology of anosmia in patients with CRS is still largely unknown. There are 2 potential broad causes of olfactory loss in patients with CRS: conductive loss caused by airflow obstruction in the olfactory fissure and sensory nerve loss caused by cell damage at the neuronal level.[28] Because of the presence of nasal polyps and high levels of type 2 helper T cells and other proinflammatory cytokines, patients with CRSwNP are susceptible to both etiologies.[29–31] Odorous molecules need to enter the olfactory area through the area between the medial middle turbinate and the nasal septum.[32] Therefore, to restore olfactory function in patients with CRS, in addition to medication therapy to improve chronic inflammation, it is necessary to ensure that the olfactory fissure is open enough during surgery.

In the present study, the anterior part of the middle turbinate (including the attachment of the base of the frontal sinus) and the superior turbinate were removed in the mEESS group. The results showed that the olfactory function of the mEESS group was significantly higher than that of the FESS group at 6 months after the operation. Extended sinus opening can restore the airflow of the olfactory fissure more thoroughly and alleviate olfactory problems in patients with CRS. However, after we followed the patients in the 2 groups for 1 year, we found that although the sense of smell in the 2 groups was better than that before the operation, there was no significant difference between the 2 groups, and overall olfaction was worse than that at 6 months

after operation; this may be related to the infiltration of inflammatory cells. On the one hand, there may be inflammatory factors in the nasal cavity of CRS patients that can inhibit nerve regeneration, differentiation, and survival; on the other hand, allergic reactions may aggravate olfactory disorders.[30] Although the patients in the present study regularly used nasal glucocorticoids to improve inflammation, persistent inflammatory changes eventually led to persistent olfactory dysfunction. How to improve persistent anosmia needs further study. In the present study, only the VAS score was used to analyze the subjective results of olfactory loss, which is an important limitation of this study. The number of patients followed was small, the follow-up period was short. Thus, in future studies, the sample size needs to be increased, and the follow-up period needs to be extended to evaluate long-term outcomes.

Our study showed that compared to FESS, "protective middle turbinate-extensive endoscopic sinus surgery" better improved the outcome of patients with CRSwNPwAR. This surgical approach helps to improve short-term patient satisfaction, olfactory sense, and frontal sinus drainage, and the long-term effects of this approach need further study.

STATEMENT OF ETHICS

This study was approved by the Institutional Review Board of The First Affiliated Hospital of Chongqing Medical University (2016-28).

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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Data Availability

The data that support the findings of this study are available from the corresponding author, (Yang Shen, and Yucheng Yang), upon reasonable request.

AI Assistance Disclosure

Not applicable.

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