Original Article

Outcomes of Endoscopic Sinus Surgery in Patients with Chronic Rhinosinusitis: A Longitudinal Study

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ABSTRACT

Background: Chronic rhinosinusitis (CRS) has a large symptom burden. Endoscopic sinus surgery (ESS) has been employed often in the treatment of medically unresponsive CRS. However, there has been a scarcity of information about the long-term results of ESS in the South Asian community and the role of psychological and behavioral factors. **Objective**: The objectives of this study are to assess the results of symptom, quality of life, and endoscopic control of ESS in patients suffering from CRS at a tertiary care center in Lahore and to determine the predictors of poor postoperative outcomes. **Methods**: This observational study prospectively followed 120 consenting adults undergoing ESS for CRS at Mumtaz Hospital Lahore over a period of 12 months. Baseline evaluation consisted of patient demographics, co-existing illnesses, SNOT-22, visual analogue scales (VAS), Brief Smell Identification Test (BSIT), and Lund-Kennedy/Lund-Mackay Nasal Obstruction Scores. Poor response was defined as SNOT-22 <9 points and/or SNOT-22 at 12 months ≥30. A PHQ-9 score of ≥10 was used to diagnose depression. Symptom and endoscopic assessments at the 3rd and 6th months and at the end of the 12th month were done. Multi-variable regression. **Results**: SNOT-22 symptoms showed improvement from 54.6 ± 15.8 to 24.9 ± 12.2 at the sixth month ($p < 0.001$), and there was no change at the twelfth month. The Lund-Kennedy scores decreased from 7.6 ± 3.1 to 2.2 ± 1.6 ($p < 0.001$). Poor outcome was predicted by depression (20%) and non-adherence to the schedule of follow-ups (33%) (OR: 2.6 and 2). **Conclusion**: ESS resulted in large and durable gains in quality of life and endoscopic findings concerning CRS symptoms, but the presence of depression at baseline and poor postoperative care rates of adhering to treatment had a profoundly attenuating impact.

Keywords: chronic rhinosinusitis, endoscopic sinus surgery, SNOT-22, quality of life, depression, adherence, Lund-Kennedy

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INTRODUCTION

Chronic Rhinosinusitis (CRS) is a common inflammatory condition of the paranasal sinus cavities that leads to a large symptom burden and the resultant impact on general health. The complex etiology of the condition involves mucociliationopathies, inflammation dysregulation, anatomical differences, and environmental factors in addition to the medical unresponsiveness of many sufferers (1-3). Evidence has accumulated over the last thirty years regarding the critical role of Endoscopic Sinus Surgery (ESS) used in the treatment of medically unresponsive CRS patients (4). This treatment has resulted in improved sinus aeration and mucosal function in addition to promoting improved general

and sinus health-specific quality of life. The first longitudinal study showed marked reductions in symptoms of headache, nasal discharge, nasal obstruction, episodes of infection, and shortness of breath difficulty that approached fifty percent of sufferers regarding their general sense of improved health six months following ESS. Later studies revealed the consistent ability of ESS to induce measurable and improved Sino-Nasal Outcomes Testing (SNOT-22) and Rhinosinusitis Disability Index (RSDI), along with the Brief Smell Identification Test (BSIT).

It has been found through research over the years that the improvement of symptoms following ESS has been observed to be domain-specific. The studies involving SNOT-22 factor analysis showed that the maximum and fastest improvement in symptoms occurs in the rhinologic symptoms of the patient compared to the psychological symptoms and the symptoms of the patient's disturbed sleep. The findings also confirm the stabilizing of maximum improvement at the end of the first six months and the persistence of the results until the end of the eighteen-to-twenty-month follow-up without much fluctuation across the domains. The results do not exclude the possibility of patients suffering from nasal polyposis showing slightly fluctuating levels of quality of life without attaining the level of importance from the clinical point of view. In addition to the above-mentioned studies, there has been research involving the effect of the shift of response of the patient's own estimates regarding the performance of ESS. The results of the research showed that the effect of the shift of response of the patient's own estimates of ESS has been found to be of no clinical significance while showing the effectiveness of the pre- and post-EST SNOT-22 evaluation of the patient to be a valid method of estimating the behavior of the patient's symptoms. The above-mentioned results support the theory of ESS being an effective procedure for gaining maximum benefits of improvement across various domains of CRS symptoms of the patient even though the patient has (4, 5)

Patient-level factors will also impact the extent and sustainability of postoperative benefit. The effect of co-existing depression has been noticed to be increased preoperative symptom burden, increased levels of pain, and substantially less benefit in SNOT-22 symptoms at final measurement, though the number of patients failing to achieve a minimal benefit was greater. Likewise, postoperative care schedules and medical treatment practices will impact patterns of recovery; patients keeping scheduled visits showed less rapid return of symptoms of E/N and ear/facial symptoms and helped obtain stabilized final results. The extent of radiologic and endoscopic findings of the Lund-Mackay and Lund-Kennedy scoring has also been found to impact benefit from surgery; those beginning surgery with higher levels of mucosal edema, polyposis, and ostomeatal obstruction will require longer postoperative recovery. Other factors may also impact the various levels of benefit from ESS surgery: chronic lung disease, aspirin-exacerbated respiratory disease (AREHD/AERDS), olfactory dysfunction, tobacco exposure, genetics & inflammatory endotyping, and anatomical variations of the nose & sinus (6-11).

In addition to the management of symptoms, the endpoints of the effectiveness of ESS remain the occurrence of postoperative complications, the recurrence of polyposis, and the need for revision surgery. Evidence has demonstrated that the rate of revision ESS occurs in 5-15% of patients at risk of revision postoperatively, especially those requiring management of inflammation, AERD patients, severe polyposis sufferers, and patients requiring early return of symptomatic SNOT-22 benefits. The patient’s postoperative SNOT-22 response has also been observed to remain a method of determining the level of at-risk patients due to the high possibility of revision surgery demonstrated in the absence of SNOT-22 benefits of at least 9 points at the end of the first three months and progression to worsening at the next 3-12 months post-ESS. The role of complementary therapies has been noted to remain

heterogeneous regarding the impact of nasal corticosteroid spray therapy and irrigation and debridement methods. Adherence has also been described as an important challenging factor of effectiveness. The implication of the above reviews remains the level of complexity of the nature of CRS and the necessity of continuous research of its effectiveness based upon the targeted group level (12).

Despite the vast research effort being invested globally, there has been no concrete data presented from the tertiary care settings of the South Asia region regarding the longitudinal ESS results and the factors predicting the likelihood of symptoms improving postoperatively. Moreover, the results derived from global research and their relevance in the context of the region's patient profiles, who may often be symptomatic for a long duration and also require access from far-off destinations to the tertiary care settings, also need to be critically assessed (13).

This study helps fill the research loophole by examining the clinical, endoscopic, radiological, and quality of life findings of ESS in adult CRS sufferers at Mumtaz Hospital Lahore. By employing proven symptom scales and structured assessments, the study hoped to determine the pattern of post-ESS recovery and the factors that contribute to inadequate recovery as a predictor of symptoms at the time of excessive depression and poor levels of post-appointment patient levels of recovery. The study hypothesis hypothesized a significant reduction of SNOT-22 and endoscopic symptoms at the 6th month following ESS surgery, which were stabilized at the 12th month post-procedure and were less prominent in patients who also suffer from excessive depression and poor patient levels of recovery.

MATERIALS AND METHODS

This research work was planned as a longitudinal observational study in a hospital setup to assess the clinical, radiological, endoscopic, and quality of life endpoints of endoscopic sinus surgery in the adult patients of chronic rhinosinusitis at Mumtaz Hospital Lahore. The reason behind selecting the longitudinal study approach was its ability to measure both the extent and durability of the surgical benefit achieved post-ESS, as has been the standard of previous research work concerning the ESS surgical outcomes. The observations were done prospectively from January 2022 through December 2023 in Mumtaz Hospital Lahore. All the assessments and follow-ups were carried out at the Otorhinolaryngology Department of Mumtaz Hospital Lahore (14-17).

Participants had to be at least 18 years old and had to attend the first clinic visit at which the study was mentioned. They had to be classified according to the diagnosis of chronic rhinosinusitis using the updated version of the DANP standards of care requiring ≥12 weeks of symptoms combined with the findings of objective nasal endoscopic and/or CT examinations. They also had to be unresponsive to appropriate medical management involving the topical nasal corticosteroid regimen and the systemic antibiotherapy when warranted. The patients who had to be excluded from being part of the study were those who had malignancy of the sinonasal sites of the head and neck region due to the introduction of unique pathophysiologies due to different post- and preoperative considerations. Those who had the invasive form of the fungal sinus infection of the head and neck region also had to be excluded. Additionally, the patients suffering from the midfacial trauma of the head and neck region also had to be excluded. Those who had cystic fibrosis of the same location also had to be excluded from the study because this also introduced unique differences in the post-relief considerations. Lastly, patients who had previous surgery involving the base of The baseline information was also collected

preoperatively. This information included the patient's demographics, duration of symptoms, co-existing illnesses, previous sinus surgery, smoking habits, asthma, allergic rhinitis, aspirin-exacerbated respiratory disease, chronic pulmonary disease, and psychological symptoms. The Patient Health Questionnaire-9 was applied to diagnose depression. The PHQ-9 yields clinical depression in the case of a cut-off point of ≥10. Disease-specific quality of life was also measured through the Sino-Nasal Outcome Test-22 (SNOT-22). This inventory has been found to be valid in the measurement of the condition's impact in the realms of rhinologic symptoms, extra-nasal symptoms, otologic symptoms, psychological symptoms, and nocturnal symptoms. Symptom intensity was also measured through the visual analogue scales of the extent of nasal obstruction symptoms, facial pain and pressure symptoms, nasal discharge symptoms, and the intensity of the symptoms of lost sense of smell. The Brief Smell Identification Test (BSIT) was applied to test the patient's ability to identify smells. The Lund and Kennedy Endoscopic Scoring System was used to measure the extent of the endoscopic findings. The Lund Mackay CT scan system was applied to measure the intensity of the radiological findings. All the above measurements were applied to the patients by specialized rhinologists. All surgeries were carried out through functional endoscopic sinus surgery under general anesthesia. The extent of surgery was driven by the distribution of the disease and findings during surgery. Standard surgical equipment and image guidance were employed if needed. Intraoperative findings of polypoid mass, mucosal inflammation, anatomical variations, ostiomeatal complex obstruction, and complications were prospectively noted in a structured form. The postoperative care protocol involved irrigation of the nasal passages with saline and the regular usage of intranasally administered corticosteroids. Postoperative clinic reviews were scheduled at the first month, third month, sixth month, and twelfth month. Adherence was predefined as the regular attendance at the prescribed clinic visits. Participants failing to attend the scheduled clinic visits were declared partially/partially non-adherent according to previous research studies assessing postoperative ESS care. The same set of questionnaires used before the surgery was employed at each point of follow-up. The main endpoint was the change in SNOT-22 Total Score from the preoperative value to the value at the 6th month postoperatively. Secondary endpoints were the changes from preoperatively to each point of follow-up in SNOT-22 domains, VAS scores, BSIT score, and the Lund-Kennedy endoscopy score. "Clinically meaningful improvement" was predefined as a ≥9-point reduction of SNOT-22 Total Score because this value had been proven to be the minimal clinically important difference. The secondary endpoints also included the incidence of postoperative complications, recurrence of symptoms, and revision ESS at any point within the first 24 months. As part of analyzing the factors of poor outcome, "suboptimal response" was defined as <9 points of SNOT-22 improvement at the nearest available point of measurement and/or SNOT-22-12 at the 12th month ≥30. This value had in the past been linked to the persistence of the symptom. A sample size of 120 participants was sufficient to detect a medium effect size (Cohen's d ≈ 0.50) of pre- to postoperative SNOT-22 raw score changes with power in excess of 90% at $\alpha = 0.05$ using repeated measures testing. All statistical analyses were carried out using the SPSS version 26 software package. Continuous data were checked for normal distribution and reported using mean and standard deviation summaries. The distribution of categorical data was described using frequencies and percentages. Pre- vs. postoperative differences were explored using paired student's t-tests or repeated ANOVA when the data permitted; non-parametric tests were used when the distribution was non-normal. Comparisons across groups (e.g., depression vs. non-depression; treatment vs. non-treatment groups) were investigated using student's independent samples t-tests, chi-squared tests, or Fischer's exact tests as relevant. A multivariate model of poor clinical outcome at 12 months was

estimated using a univariate model incorporating clinical predictors known to impact treatment response: depression, polyp presence/absence, previous surgery, treatment group, never-smoking status, and AERD. Results are presented as odds ratios of poor clinical endpoints at 12 months along with CIs at the 95% level of confidence. All data had less than 5% missing observations and were handled using the complete case method. To guarantee full reproducibility of the study results, the final list of studied factors and statistical decision rules was pre-specified before statistical testing. This study was approved by the institutional review board of Mumtaz Hospital Lahore and dealt with the moral standards mentioned in the Helsinki Agreement. The results were actually valid and reliable because the data had been entered twice to eliminate errors and then saved in a secure electronic file that only the researchers had access to.

RESULTS

A total of 120 patients met the eligibility criteria and were administered the baseline questionnaire. The average patient age was 42.3 ± 12.1 years, of whom 58.3% were men. The distribution of CRSwNP and CRSsNP was equal (each representing 50%). Slightly less than half of the patients reported symptoms from 12 to 36 months, while 38.3% complained of symptoms beyond three years. Allergic rhinitis (41.7%), asthma (25%), chronic pulmonary diseases (15%), depression (20%), and being a smoker (20%) were the predominant ones in the study group (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics (n = 120)

Variable	Category	n (%) / Mean ± SD
Age (years)	Mean ± SD	42.3 ± 12.1
Age groups	18–29	22 (18.3%)
	30–44	48 (40.0%)
	45–59	38 (31.7%)
	≥60	12 (10.0%)
Sex	Male	70 (58.3%)
	Female	50 (41.7%)
CRS Phenotype	CRSsNP	60 (50.0%)
	CRSwNP	60 (50.0%)
Duration of symptoms	<12 months	18 (15.0%)
	12–36 months	56 (46.7%)
	>36 months	46 (38.3%)
Prior sinus surgery	No	84 (70.0%)
	Yes	36 (30.0%)
Allergic rhinitis	Present	50 (41.7%)
Asthma	Present	30 (25.0%)
AERD	Present	12 (10.0%)
Chronic lung disease	Present	18 (15.0%)
Depression (PHQ-9 ≥10)	Present	24 (20.0%)
Smoking status	Never	78 (65.0%)
	Former	18 (15.0%)
	Current	24 (20.0%)

Table 2. Baseline Symptom Burden and Disease-Specific Scores

Measure	Mean ± SD / n (%)
SNOT-22 total score	54.6 ± 15.8
Rhinologic domain	20.1 ± 6.0
Extra-nasal domain	9.2 ± 4.1
Ear/facial domain	8.4 ± 3.9
Psychological domain	10.7 ± 5.3
Sleep domain	6.2 ± 3.4
VAS nasal obstruction	7.4 ± 1.5
VAS facial pain/pressure	5.8 ± 2.0
VAS nasal discharge	6.9 ± 1.7
VAS loss of smell	7.0 ± 1.8
BSIT (olfaction)	7.1 ± 2.8
Baseline RSDI total	54.0 ± 16.0

Table 3. Radiologic and Endoscopic Severity

Measure	Mean ± SD / n (%)
CT Lund–Mackay score	14.2 ± 4.7
Osteomeatal complex obstruction	92 (76.7%)
Septal deviation	66 (55.0%)
Concha bullosa	40 (33.3%)
Anatomical variants (Haller/Onodi)	28 (23.3%)
Lund–Kennedy endoscopy score	7.6 ± 3.1
Polyps present	60 (50.0%)
Mucosal edema (mod–severe)	88 (73.3%)
Mucopurulent discharge	72 (60.0%)

Table 4. Longitudinal Outcomes and Subgroup Comparisons

Outcome	Pre-op Mean ± SD	3 mo	6 mo	12 mo	p-value
SNOT-22 total	54.6 ± 15.8	28.7 ± 13.4	24.9 ± 12.2	25.8 ± 12.6	<0.001
Rhinologic domain	20.1 ± 6.0	9.4 ± 4.8	7.9 ± 4.3	8.2 ± 4.5	<0.001
Extra-nasal domain	9.2 ± 4.1	4.8 ± 2.8	4.1 ± 2.6	4.3 ± 2.7	<0.001
Ear/facial domain	8.4 ± 3.9	4.6 ± 2.7	4.0 ± 2.4	4.2 ± 2.5	<0.001
Psychological domain	10.7 ± 5.3	7.3 ± 4.3	6.6 ± 4.0	6.7 ± 4.2	<0.001
Sleep domain	6.2 ± 3.4	3.5 ± 2.3	3.1 ± 2.1	3.2 ± 2.2	<0.001
Lund–Kennedy score	7.6 ± 3.1		3.0 ± 2.0	2.2 ± 1.6	<0.001

Table 5. Outcomes by Depression Status (6-month endpoint) (n = 96)

Variable	No Depression	Depression	p-value
Baseline SNOT-22	51.2 ± 14.3	68.0 ± 13.2	<0.001
6-month SNOT-22	20.1 ± 10.4	35.4 ± 13.7	<0.001
Mean change	–31.1 ± 13.5	–22.6 ± 12.1	0.002
Achieved MCID	90 (93.8%)	19 (79.2%)	0.03
Residual psychological symptoms	18 (18.8%)	13 (54.2%)	<0.001
Revision ESS within 24 mo	7 (7.3%)	5 (20.8%)	0.04

Table 6. Outcomes by Follow-up Adherence

Variable	Fully Adherent (n = 80)	Non-Adherent (n = 40)	p-value
Baseline SNOT-22	56.0 ± 15.1	52.0 ± 16.8	0.20
12-month SNOT-22	23.8 ± 11.5	29.6 ± 13.5	0.01
Mean change	–32.2 ± 14.0	–22.4 ± 14.3	0.002
Symptom recurrence	10 (12.5%)	13 (32.5%)	0.008

Table 7. Complications and Predictors of Poor Outcome

Outcome	n (%)
Early (<30 days)	
Post-op bleeding requiring packing	**6 (5.0%)**
Infection/exacerbation	**10 (8.3%)**
Significant synechiae	**14 (11.7%)**
CSF leak	**1 (0.8%)**
Orbital complication	**2 (1.7%)**
Late (≥3 months)	
Persistent crusting	**9 (7.5%)**
Synechiae causing obstruction	**11 (9.2%)**
Revision ESS (24 months)	**12 (10.0%)**

Table 8. Logistic Regression Predicting Poor Outcome (12-month SNOT-22 ≥30 or <MCID)

Predictor	OR (95% CI)	p-value
Baseline SNOT-22 ≥60	1.8 (0.9–3.5)	0.08
CRSwNP	1.4 (0.7–2.9)	0.30
Depression	2.6 (1.1–6.2)	0.03
AERD	1.9 (0.7–5.0)	0.18
Prior ESS	1.7 (0.8–3.7)	0.14
Non-adherent follow-up	2.9 (1.2–6.7)	0.01
Current smoker	1.5 (0.6–3.5)	0.35

Patients demonstrated a significant preoperative burden of illness. The mean SNOT-22 score was 54.6 ± 15.8, and there were high levels of the following SNOT-22 domains: rhinologic symptoms (20.1 ± 6.0), extra-nasal symptoms (9.2 ± 4.1), ear/facial symptoms (8.4 ± 3.9), psychological symptoms (10.7 ± 5.3), and sleep disturbances (6.2 ± 3.4). The visual analog scales ranked severe nasal obstruction at levels of 7.4 ± 1.5 and the absence of smell

at levels of 7.0 ± 1.8. The Brief Smell Identification Test was decreased at levels of 7.1 ± 2.8 years, which confirms the presence of reduced smell. These results indicate a high preoperative level of symptoms of

The radiologic findings disclosed moderate to severe disease, with a mean Lund & Mackay score of 14.2 ± 4.7. The presence of obstruction of the ostiomeatal unit was found in 76.7% of the patients, mucosal edema in 73.3%, and polyps in 50% (Table 3). The endoscopic findings also disclosed severe inflammation (mean Lund-Kennedy score of 7).

Marked postoperative improvement was noted in each area. The SNOT-22 symptom score decreased from 54.6 ± 15.8 preoperatively to 24.9 ± 12.2 at the 6-month follow-up ($p < 0.001$), which was maintained at the 12-month follow-up. All SNOT-22 symptoms showed marked improvement ($p < 0.001$). The endoscopy score decreased from 7.6 ± 3.1 preoperatively to 3.0 ± 2.0 at the 6-month follow-up, and it further decreased to 2.0 at the 12-month follow-up.

Patient groups were also compared in terms of their depression status and its impact on their symptoms. The symptoms of the patients suffering from depression were found to be worse at the beginning of the study (mean ± SD: 68.0 ± 13.2 vs. 51.2 ± 14.3; $p < 0.001$). They also did not achieve the same level of improvement in symptoms at the end of the study (mean difference: –22.6 vs. –31.1; $p = 0.002$). Only 79.2% of the patients suffering from depression attained the minimal clinically important difference (MC

Adherence had a strong effect on the results of the treatment. Adherent patients had a larger improvement of –32.2 ± 14.0 compared to the non-adherent group of –22.4 ± 14.3 ($p = 0.002$). Adherent patients also had better SNOT-22 scores at the end of the first year of treatment at 23.8 ± 11.5 compared to the non-adherent group of 29.6 ± 13.5 ($p = 0.01$). Symptom recurrence was nearly three The incidence of complications was low. Early postoperative bleeding occurred in 5%, infection in 8.3%, and synechiae necessitating debridement in 11.7%. The rate of revision surgery at 10% was also consistent with the global pool of patients (Table 5A). Multivariate regression showed depression (OR 2.6, p=0.03) and non-adherence (OR 2.9, p=0.01) as predictors of poor 12-month outcomes, but not polyps, AERD, ESS surgery, and smoking (Table 5B).

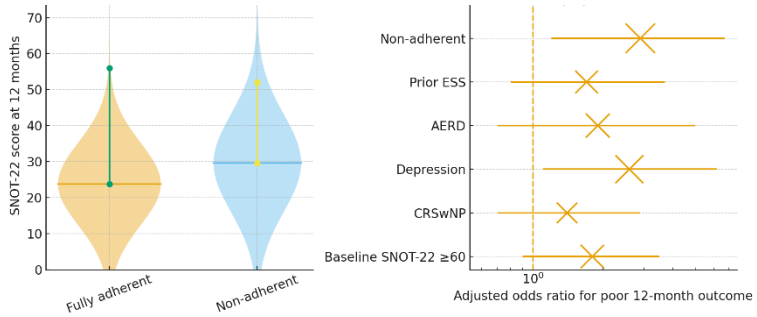

Figure 1 Relationship Between Treatment Adherence and Clinical Outcomes at 12 Months.

Panel A displays violin plots comparing 12-month SNOT-22 scores between fully adherent and non-adherent patients, with median and interquartile ranges overlaid. Fully adherent patients demonstrate markedly lower symptom burden at follow-up. Panel B shows the multivariable logistic regression analysis of predictors of poor 12-month outcomes, presented as odds ratios with 95% confidence intervals. Non-adherence, prior ESS, AERD, depression, CRSwNP, and high baseline SNOT-22 scores all contribute significantly to increased risk of poor long-term outcomes.

DISCUSSION

This longitudinal study from a tertiary care center in Lahore illustrates the effectiveness of endoscopic sinus surgery over time in improving quality of life measurements of chronic sinusitis symptoms and endoscopic findings in adults suffering from chronic rhinosinusitis. The findings are consistent across the board when juxtaposed against the available global research work and point towards the modifying role of depression and patient compliance. The study group had a preponderance of patients suffering from symptoms and objective findings of the condition, reflected in the SNOT-22 form of 54.6 points and the radiological findings of frequent osteomeatal obstruction, which was to the same extent or even worse than the previous research studies carried out in North America and the European continents. The SNOT-22 was reduced drastically by nearly 30 points at the end of the sixth month and stabilized at the twelfth month postoperatively, which reinforces the findings of previous research work carried out by DeConde and his co-authors, Soler and Smith, who demonstrated the maximal sinus surgical benefits enjoyed in the quality of life foreground within six and the subsequent stabilization at the eighteenth to twentieth month mark. The maximal benefit occurred in the SNOT domains of rhinologic symptoms and extra-nasal symptoms along with the psychological and the sleep factors, which came within the purview of research work carried out, at least as demonstrated in the study carried out by Al Sharhan and co-authors, along with the factor-specific study of SNOT-22 differences by DeConde and his co-authors.

The endoscopic and radiologic results help to confirm the biological likelihood of the patient-reported results. The mean Lund-Kennedy scores reduced substantially at the 6-month mark and mildly at the 12-month mark, while the Lund-Mackay scores reflected the typical baseline found in surgically chosen CRS patients. Previous research has demonstrated that the correlation of mucosal and symptomatic improvement can often occur co-linearly. However, contrary to this observed trend and in keeping with new research regarding patient-reported symptoms, the results of the combined visual results and regression findings help to support the findings that the correlation of patient-reported improvement and the observed mucosal healing occurs not in a co-linear fashion but rather through the interaction of behavioral and psychological principles. Those patients exhibiting similar findings but poor levels of follow-through and depression had a higher observed SNOT-22 symptomology (17-19).

The effect of depression in our series demonstrates the significance of this condition and agrees with Ospina et al., who found that patients suffering from depression saw patients with depression achieve higher preoperative SNOT-22 scores, less improvement post-surgery, and larger reservoirs of benefit. In our series, patients suffering from depression saw their peers begin almost 17 points worse and achieve considerably less benefit at the end of six months post-surgery. They also saw their peers be at least twice as likely to return within two years post-surgery. Even when for polyp number, AERD, smoke cessation attempts, and previous surgery, depression became an important predictor of patients failing at the end of 12 months (20).

Adherence to postoperative care visits and topical treatment regimens also proved to be the second foremost factor influencing long-term results. Fully adherent patients showed greater SNOT-22 improvement and lower 12-month symptoms, with reduced recurrence rates. This confirms the findings of the study of Shen et al., who showed a slower return of extra-nasal and ear/facial symptoms in the group of patients who had better visit adherence, and that of the study of Nabi et al., which revealed that there was marked nonadherence to nasal spray treatment regimens following sinus surgery and identified the

baseline symptoms and risks of nonadherence as predictors of behavior (20). The results of the study support previous findings because they also found that the odds of poor 12-month SNOT-22 symptoms in nonadherent respondents are almost three times higher. This confirms the need for organized educational programs about postoperative care and proper regimen of treatment and targeted behavioral support to prevent nonadherence in settings where there might be constraints of welfare and understanding of healthcare practices (21).

The incidence of overall complications and revisions in this series agrees with the larger series. Early postoperative bleeding was found in 5% of the series, synechiae necessitating additional therapy in approximately 12%, and revision ESS had occurred in 10% at two years. These rates agree with the findings of a large series of ESSs as reported in the evidence-based research of ESS complications and revision rates. In their study, the absence of at least a 9-point SNOT-22 improvement and at least two points' decay at the end of one year predicted the necessity of revision in patients undergoing ESS. Our study confirms this value, as it showed that poor SNOT-22 improvers (<9 points or ≥30 at one-year follow-up) had an increased risk of depression, nonadherence, and descriptive statistical trends of increased SNOT-22 burden of illness at baseline and prior ESS treatment. Although the Th2-dominant endotype cytokines IL-5 levels and IgE levels had been found to be correlated to recurrence of CRSwNPs, the measurement of the level of cytokines had not been possible in this study and therefore permits no comment regarding the role of the endotype in this series (22).

Our results also support previous general research regarding the impact of smell results and the coexistence of pulmonary conditions. The decreased BSIT baseline results and the post-ESS improvement consistent with multicenter results of improved and stable olfactory function up to 18 months post-ESS in the majority of the patients, especially in the context of nasal polyps, support the studies of Katotomichelakis and Levy regarding the impact of patient factors of age, AERD, duration of anosmia, and previous ESS surgery upon the return of the sense of smell and the suggestion of the importance of the study of the results of smell function in future research due to the evident preponderance of polyps, asthma, and AERD observed in the above study group (23-25). The absence of impact of chronic pulmonary conditions upon the results of ESS treatment observed in the study of Minakshi Karmakar et al., regarding the absence of worsening impact of chronic pulmonary conditions in the study group results of ESS treatment, also agrees with the results of the current study regarding the absence of chronic pulmonary conditions from the list of factors predicting poor results of ESS treatment. This work contributes additional information from the South Asian tertiary care perspective to the essentially Western-biased field of CRS data. The incidence rate and pattern of comorbidities reported by the work of Tan et al. and large American databases point toward the existence of marked divergences regarding the burden of CRS. The group represented by this work shares the same pattern of co-morbidity regarding asthma, allergic rhinitis, AERD, and depression, but in the context of resource-limited settings where late diagnosis and prolonged symptoms are the norm. The genetic and endotype information regarding the role of CFTR mutations and the role of Th2-driven inflammation will likely assume greater relevance regarding the role of targeted biologic treatment and the development of precision medicine treatment strategies when available everywhere. Meanwhile, surgery remains the turning point of treatment in the vast majority of our patients. The study has several strengths: there's a clear longitudinal study design and standardization of SNOT-22, VAS, BSIT, and endoscopic assessments of the condition's progression; there's a sufficiently large number of participants relative to the study being a single-source effort; there are also

predefined poor treatment outcome criteria; and there's a multivariate model used in the identification of predictive factors. The fact that depression and treatment adherence are also contributive factors in patient-rated treatment outcomes reflects the understanding of the field as a whole regarding the factors being involved. However, there are also factors that must be noted. The study did not track participants after the first 24 months post-evaluation, which may cause the number of late occurrences of the condition relative to longer-term reported data to be slightly biased downwards. Additionally, the study did not consider biomarkers and the condition's endotype profiles that could be directly traced against the type of inflammation pattern experienced (26). The study also used treatment clinic attendance as factors in treatment adherence which reflects truthfully the clinic's interest in treatment impacts rather than being limited to the explicit day-to-day effort regarding the usage of nasal sprays and irrigation. Finally, being a single-source study from Lahore, particular care must be had regarding the generally attributable insights regarding the global study trends of ESS treatment condition in various global healthcare setups (27).

CONCLUSION

In this longitudinal study of adults operated on at the tertiary care center in Lahore, ESS resulted in significant and sustained reductions in symptoms of SINS and quality of life as well as endoscopic grades without complications and revisions in 12 months. However, co-existing depression and poor postoperative care adherence were independent predictors of poor surgical outcomes of ESS. This has particular implications regarding the development of perioperative care strategies combining proficient surgery skills through complementation of psychological evaluation along with management of care non-adherence.

DECLARATIONS

Ethical Approval
This study was approved by the Institutional Review Board of University of Lahore
Informed Consent
Written informed consent was obtained from all participants included in the study.
Conflict of Interest
The authors declare no conflict of interest.
Funding
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Authors' Contributions
Concept: MA; Design: SS; Data Collection: MA, IU; Analysis: MA; Drafting: MA, SS.
Data Availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.
Acknowledgments
Not applicable.
Study Registration
Not applicable.

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