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Original Research Article

Outcomes of Endoscopic Sinus Surgery for Chronic Rhinosinusitis With Nasal Polyposis and Risk Factors of Recurrence in a Tertiary Care Teaching Hospital

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Abstract

Background: Endoscopic sinus surgery (ESS) has become the gold standard for treating patients with chronic rhinosinusitis (CRS) refractory to medical therapy. It is considered a relatively safe and effective procedure in all age groups, with overall success rates ranging from 76% to 97.5%. However, failure of primary endoscopic sinus surgery (PESS) occurs at a rate ranging from 2% to 24%. Patients who are still symptomatic after PESS and optimal medical therapy are candidates for revision endoscopic sinus surgery (RESS).

Objectives: to study the outcomes of ESS and assess the risk factors of recurrence of nasal polyps, as well as to compare the outcomes of PESS and RESS at a tertiary care teaching hospital.

Design: A retrospective cross-sectional study.

Methods: This study is conducted on patients with CRS with nasal polyps (CRSwNP) who underwent ESS at King Saud University Medical City (KSUMC) between May 2015 and December 2021. During this period, ESS was performed 470 times for CRSwNP. The Sinonasal Outcome Test 22 (SNOT-22) questionnaire, the Lund–Kennedy (LK) score, the Lund–MacKay (LM) score, and the polyp grading system were used to evaluate subjective and objective outcomes. They were scored preoperatively and from 6 to 12 months postoperatively.

Results: Out of the 470 endoscopic sinus surgeries, 321 (68.3%) were PESS and 149 (31.7%) were RESS. Asthma, aspirin sensitivity, and Samter's triad were observed more in the RESS group. The LK and LM scores were significantly different between primary and revision sinus surgeries, revealing that PESS patients had better postoperative LK and LM scores. The RESS patients had significantly worse postoperative SNOT-22 scores compared to PESS patients.

Conclusion: Lund–MacKay, Lund–Kennedy, and SNOT-22 scores improved after ESS for both primary and revision ESS patients, with better outcomes observed after PESS compared to RESS. The presence of asthma, aspirin sensitivity, Samter's Triad, high-grade nasal polyps, and older age were identified as risk factors for CRSwNP recurrence, which may require RESS.

Keywords: chronic rhinosinusitis, nasal polyposis, sinus surgery, revision surgery, surgical outcomes, risk factors, recurrence

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Introduction

Chronic rhinosinusitis (CRS) is described as an inflammation of the nose and paranasal sinuses. It is characterized by 2 or more symptoms of nasal obstruction, nasal discharge, facial pressure, and loss of smell, one of which should be either

nasal obstruction or nasal discharge. The symptoms must be present for at least 12 weeks. In addition to these symptoms, endoscopic signs of nasal polyps, discharge, edema, and computed tomography (CT) changes are used in the diagnosis of CRS. Epidemiological statistics show that CRS affects both adults and children,[1–3] and it affects 5% of the general population. Furthermore, CRS encompasses diverse phenotypic expressions. Clinical and histological differences suggest 4 CRS subtypes: eosinophilic CRS with and without nasal polyps (eCRSwNP and eCRSsNP, respectively) and noneosinophilic CRS with and without nasal polyps (neCRSwNP and neCRSsNP, respectively).[4,5] However, these phenotypic expressions may not adequately represent the many underlying genetic and cellular processes that underlie this complex inflammatory disease. Consequently, CRS had an endotypic classification based on pathobiological mechanisms. Three endotypes of CRS have been classified: nontype 2 inflammation, which correlates with CRS without nasal polyps (CRSsNP) phenotype, low risk of developing asthma and disease recurrence; moderate type 2 inflammation, which contains a mixture of CRSsNP and CRS with nasal polyps (CRSwNP); and severe type 2 inflammation, which correlates with CRSwNP phenotype, high risk of developing asthma and disease recurrence.[6] CRSwNP, in particular, is well documented to be characterized by type 2 inflammation with prominent eosinophilia and the presence of high amounts of type 2 cytokines such as IL-4, IL-5, and IL-13.[7,8] Additionally, type 2 T-cell inflammation has recently been identified to influence disease severity and polyp recurrence.[9–11] As a consequence, more extensive surgical techniques have been advocated to widely access the sinuses in order to open them for local treatment and alleviate the inflammatory load.[12,13] The goal of treating CRS is to enhance sinus cavity function by reducing mucosal inflammation, treating the associated hypersecretory mucin, treating mucostasis, and reducing the reaction to environmental stimuli. Based on the strength of the evidence, medical therapy for CRS includes topical and oral corticosteroids, oral antibiotics, and topical saline; additionally, the most common therapeutic regimen includes an 8-week course of topical intranasal corticosteroids and a 3-week course of broad-spectrum or culture-directed oral antibiotics. A course of systemic corticosteroids was prescribed in the majority of cases for an average of 2 weeks.[14] Endoscopic sinus surgery (ESS) has become the gold standard for treating CRS and nasal polyposis (NP) when failed to respond to medical treatment for 6 to 12 weeks with no symptoms improvement, and it is considered a treatment that is comparatively safe and efficient for all age groups.[15–20]

According to the literature, the success rates of ESS ranged from 76% to 97.5%.[21] However, the range of failure rates varies from 2.5% to 24.5%.[22] Additionally, the presence of NP reduces the surgery's success rate by 50% to 70%.[23–25] Some patients who have failed primary endoscopic sinus surgery (PESS) will need a revision endoscopic sinus surgery (RESS).[22] Although the technique and concept of RESS is significantly similar to those of PESS, RESS can be more difficult to accomplish due to distorted anatomy, scarring, and a greater tendency for hemorrhage.[26,27] Patients with NP, asthma, Samter's triad, or frontal sinus illness are more likely to undergo RESS.[28] Prior sinus surgery has not been demonstrated to predict quality of life (QOL) results following future ESS in previous research, although no distinction has been made between individuals receiving a single or multiple-revision ESS procedure.[29,30] A review of the literature has shown that the extent of the disease, inflammation on CT scan, a history of past ESS, allergies, asthma, aspirin sensitivity, cystic fibrosis, ciliary dyskinesia, the existence of NP, and depression have predicted the long-term success rate of ESS, all of which are among the issues that have sparked debate.[17,18,23,31–35] Our main objective is to study all the outcomes of ESS and assess the risk factors associated with the recurrence of CRSwNP, as well as to compare outcome results of patients who underwent PESS and RESS at a tertiary care teaching hospital.

Materials and Methods

Study Population and Data Collection

This is a retrospective cross-sectional study conducted in the Otolaryngology department at King Saud University Medical City (KSUMC) in Riyadh, Saudi Arabia. The study recruited 714 patients who had undergone primary or revision ESS between May 2015 and December 2021. Out of these, 470 patients with CRSwNP were included in the study. An institutional review board-supported investigation was performed on data tentatively gathered from patients' electronic records through the eSiHi system. Patients with a

baseline follow-up of at least 6 months were included in the review. The exclusion criteria were as follows: age less than 18, patients who had surgery for acute sinusitis, patients who did not have NP, patients with mucocele, sinonasal tumor, granulomatous diseases, or antrochoanal polyp, and patients with nasal/sinus disease other than nasal polyps, or patients with incomplete baseline data. A full history was collected, which included patient information, such as age, type of surgery (either primary or revision), number of sinus surgeries, and whether the surgery was performed with other surgical procedures (such as septoplasty and/or turbinoplasty), as well as data concerning asthma, aspirin sensitivity, and Samter's Triad. The surgical strategy for PESS entailed a comprehensive full-house functional endoscopic sinus surgery (FESS) procedure, which included the opening of bilateral paranasal sinuses with maxillary antrostomy, anterior and posterior ethmoidectomy, complete sphenoidotomy, and frontal sinusotomy (Draf IIA). Similarly, for RESS, the approach involved a full-house FESS technique, encompassing the opening of bilateral paranasal sinuses with maxillary antrostomy, anterior and posterior ethmoidectomy, complete sphenoidotomy, and extended frontal sinusotomy (Draf IIB). PESS was indicated for patients who failed to respond to appropriate medical therapy, which includes short-course antibiotics, mucolytic agents, short-course systemic steroids, nasal steroids, and nasal irrigations. As well, RESS was indicated for patients who failed to respond to both PESS and appropriate postoperative medical therapy. Postoperatively, patients received saline irrigation, budesonide rinse, and mucolytic treatment for a minimum of 6 months. Clear instructions were provided to patients regarding nasal irrigation techniques. A 1-week follow-up after surgery was scheduled for all patients, followed by subsequent appointments every 3 months. Meticulous endoscopic debridement was conducted until the cavity exhibited complete healing. In instances where patients displayed symptoms of inflammation or presented with edematous or polypoid alterations of the sinus mucosa during the follow-up period, antibiotics and oral steroids were administered for 1 to 2 weeks.

Quality of Life Evaluation and Objective Outcomes Measurement

The Sinonasal Outcome Test 22 (SNOT-22),[36] standard sinus view CT scans, and rhinoscopy findings pre and postoperatively were used to evaluate QOL in this study. On a 6-point scale, with 0 representing no symptoms and 5 representing the most severe symptoms, the valid SNOT-22 questionnaire lists sinonasal and general symptoms connected to CRS. This survey was conducted both before surgery and between 6 and 12 months after surgery. The Lund–Mackay (LM) CT grading system was used to analyze the data from routine CT scans with a sinus view in the coronal plane.[37] The system provides a bilateral score range of 0 to 24, with scores for each paranasal sinus ranging from 0 to 2. A score of 0 suggests the absence of any abnormality, while a score of 1 indicates partial opacification and a score of 2 indicates total opacification. The osteomeatal complex (OMC) score is either 0 or 2, with a score of 0 representing a patent OMC and a score of 2 indicating an obliterated OMC. The physical findings from nasal endoscopy were evaluated using the Lund-Kennedy (LK) score, which ranges from 0 to 12 and assesses nasal polyps, edema, and discharge.[38] In terms of nasal polyps, a score of 0 indicates their absence, 1 suggests their confinement to the middle meatus, and 2 indicates their extension into the nasal cavity. As for edema, a score of 0 denotes the absence of edema, 1 indicates a mild to moderate level of edema, and 2 indicates severe edema. With regards to discharge, a score of 0 signifies no discharge, 1 represents a thin and clear discharge, and 2 indicates a thick or purulent discharge. The LK score was determined separately for each side, and the scores for each side were combined to determine the overall endoscopy score. The polyp grading system ranges from Grade 0 to 4, with Grade 0 indicating the absence of polyps, Grade 1 indicating the presence of polyps confined to the middle meatus, Grade 2 indicating polyps located outside the middle meatus, Grade 3 indicating large polyps that extend to the lower border of the inferior turbinate or those that are medial to the middle turbinate, and Grade 4 indicating large polyps that extend beyond the inferior border of the inferior turbinate or reach the nasal floor. Additionally, the study recorded whether patients underwent concomitant septoplasty, turbinoplasty, or no procedures. Moreover, CT scans and rhinoscopy findings were evaluated preoperatively and 6 to 12 months postoperatively.

Statistical Analyses

Data were analyzed using IBM SPSS Statistics software, version 26 (SPSS Inc., Chicago,

Illinois, USA). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were calculated to summarize the quantitative and categorical variables. Chi-square tests were employed to compare categorical variables like asthma, aspirin sensitivity, and Samter's Triad between the primary and revision surgery groups. Student *t*-tests were used to compare quantitative factors such as SNOT22, LM, and LK scores between the primary and revision surgery groups. Paired *t*-tests were performed to compare pre- and postoperative results. A *p*-value less than .05 was considered statistically significant for all tests. The reporting of this study conforms to the Strengthening the Reporting of Observational Studies in Epidemiology statement.[39]

Results

Patients' Characteristics, and Variables

A total of 714 patients underwent ESS. Of these, 520 (72.8%) had PESS and 194 (27.2%) had RESS. The mean age at the time of surgery was 38.25 years (± SD 12.85), ranging from 18 to 77 years. The majority of the cases, 470 (65.84%), were CRSwNP, others were CRSsNP and allergic fungal rhinosinusitis (AFRS), accounting for 153 (21.4%) and 91 (12.7%), respectively. Moreover, about one-third of the population, 204 (28.6%) had asthma, and 17 (2.4%) had aspirin (ASA) sensitivity, while 40 (5.6%) had Samter's Triad. Additionally, approximately half of the population underwent septoplasty 389 (54.4%), and 441 (61.7%) underwent turbinoplasty. Finally, the mean duration between PESS and revision surgery was 8.9 (± 6.8) years (Table 1).

Outcomes of ESS and Risk Factors of Recurrence in CRSwNP

A total of 470 patients with CRSwNP underwent ESS. Of these, 321 (68.3%) were PESS, and 149 (31.7%) were RESS. Patients with CRSwNP who underwent PESS were younger (37.5 [± 12.77]) compared to patients who underwent RESS (40.36 [± 12.87]), with a highly significant *P*-value ($P < .001$). Samter's Triad was less prevalent in the PESS group, with 20 (6.2%) patients compared to 19 (12.8%) patients in the RESS group, with a highly significant *P*-value of .017. Patients in the RESS group were more likely to have asthma and ASA sensitivity, with 83 (55.7%) and 24 (16.1%), patients, respectively, compared to those in the PESS group, with 118 (36.8%) and 28 (8.7%), patients, respectively. The *P*-values for asthma and ASA sensitivity were highly significant at $P < .001$ and .018, respectively. PESS patients were more likely to undergo turbinoplasty and septoplasty, with 218 (68.3%) and 205 (64%) patients, respectively, compared to RESS patients with 62 (41%) and 44 (23%) patients, respectively. Both turbinoplasty and septoplasty showed highly significant *P*-values ($P < .001$). The need for postoperative CT scans was significantly higher in revision cases, with 46 patients (30.9%), compared to primary cases, with 38 patients (11.8%), with a *P*-value <.001 (Table 2).

The preoperative mean SNOT-22 score for the PESS and RESS groups was 34.87 (± 27.43) and 40.14 (± 15.02), respectively. Postoperatively, the scores improved to 22 (± 19.79) and 29.08 (± 19.79) for the PESS and RESS groups, respectively. The *P*-values for both pre and postoperative scores were .568 and .328, respectively (Table 3).

The total LK score preoperatively was 4.88 (± 2.230) and 5.32 (± 2.145) for patients in the PESS and RESS groups, respectively, showing a higher score in revision cases compared to primary cases, with a statistically significant difference ($P = .048$). Postoperatively, the scores improved to 1.29 (± 1.833) and 2.12 (± 2.244) for the PESS and RESS groups, respectively, with greater improvement observed in the PESS group. The difference was also statistically significant ($P < .001$) (Table 3).

The total LM score preoperatively was 15.87 (± 6.12) in the PESS group, while the RESS group had a higher score 18.39 (± 6.07). The difference between the groups was statistically significant ($P < .001$), indicating a lower score in the PESS group. Postoperatively, the scores improved to 11.85 (± 5.64) and 11.51 (± 6.01) for the PESS and RESS groups, respectively, with a *P*-value of .555 (Table 3).

Preoperatively, in the polyp grading system, grades (G3 + G4) were higher in revision cases on both the right and left sides, with 86 (58.9%) and 85 (58.2%) cases, respectively, compared to PESS cases with 146 (46.8%), and 158 (50.5%) cases. The difference between the groups was highly significant with *P*-values of .005 and .02, respectively. Postoperatively, no significant difference was observed between PESS and RESS, as lower

Table 1. Descriptive Analysis of Study Variables.

Age at surgery	M (38.25) (± SD 12.85); range (18-77 years)	
Number of ESS	Primary surgery	520 (72.8%)
	Revision surgery	194 (27.2%)
Type of CRS	CRSwNP	470 (65.84%)
	CRSsNP	153 (21.4%)
	AFRS	91 (12.7%)
Asthma, ASA	ASA sensitivity	17 (2.4%)
	ASA sensitivity; asthma	39 (5.5%)
	ASA sensitivity; asthma; received biologics	1 (0.1%)
	Asthma	204 (28.6%)
	None	453 (63.4%)
Samter's Triad	No	674 (94.4%)
	Yes	40 (5.6%)
Septoplasty	No	325 (45.6%)
	Yes	389 (54.4%)
Turbinoplasty	No	273 (38.3%)
	Yes	441 (61.7%)
CT duration after surgery (years)	M 1.57 ± SD 1.326	
Revision case duration after first surgery (years)	M 8.9 ± SD 6.8	

SD, standard deviation; ESS, endoscopic sinus surgery; CRS, chronic rhinosinusitis; CRSwNP, chronic rhinosinusitis with nasal polyps; CRSsNP, chronic rhinosinusitis without nasal polyps; AFRS, allergic fungal rhinosinusitis; ASA, aspirin sensitivity.

polyp grades (G0 + G1) were nearly equal on the right and left sides for both PESS (256 [92.5%] and 257 [92.7%], respectively) and RESS (117 [91.4%] and 117 [91.5%], respectively), with *P*-values of .085 and .139, respectively (Table 4).

Discussion

Despite the fact that ESS is now the most widely used method for the treatment of CRS and NP, and that good success rates have been reported,[15–20,40,41] this surgical technique does not guarantee success in all patients. Even after receiving the most comprehensive medical care possible following surgery, some patients still report having symptoms that call for additional surgical therapy. Particularly NP are thought to be a major factor in failure following ESS due to their high propensity for recurrence.[24,25,42] Adequate counseling for the management of CRS, with or without NP, would result from identifying the clinical determinants of surgical outcomes and long-term success following ESS. A history of ESS is typically seen as suggestive of a poor prognosis after RESS among the several factors hypothesized to influence surgical outcomes.[17,18,24,32,34] Due to the lack of anatomical markers, greater bleeding, and numerous adhesions, RESS is thought to be more challenging. This could possibly account for the RESS group's greater failure rate and likelihood of significant consequences.

Subjective and objective outcomes for patients who underwent RESS did not, however, seem to differ noticeably from those of patients who

Table 2. Comparison of Age, Samter Triad, Septoplasty, Turbinoplasty, and Post-op CT in Patients With Primary and Revision ESS for CRSwNP.

Item		Total *N*	Number of ESS		□^{2} (*P*-value)
			Primary No. (%)	Revision No. (%)	
Age at surgery (years) (± SD)			37.5 (± 12.77)	40.36 (± 12.87)	2.69* .000
Samter's Triad	No	431	301 (93.8%)	130 (87.2%)	5.68^ .017
	Yes	39	20 (6.2%)	19 (12.8%)	
ASA sensitivity	No	418	293 (91.3%)	125 (83.9%)	5.640^ .018
	Yes	52	28 (8.7%)	24 (16.1%)	
Asthma	No	269	203 (63.2%)	66 (44.3%)	14.921^ .000
	Yes	201	118 (36.8%)	83 (55.7%)	
Turbinoplasty	No	190	101 (31.7%)	89 (59%)	30.18^ .000
	Yes	280	218 (68.3%)	62 (41%)	
Septoplasty	No	230	115 (36%)	115 (77%)	70.43^ .000
	Yes	240	205 (64%)	44 (23%)	
CT post-op	No	386	283 (88.2%)	103 (69.1%)	25.12^ .000
	Yes	84	38 (11.8%)	46 (30.9%)	

SD, standard deviation; *, Student's *t*-test; ^, chi-square; ESS, endoscopic sinus surgery; ASA, aspirin sensitivity; CRSwNP, chronic rhinosinusitis with nasal polyps.

underwent PESS during in-office follow-up. Due to this, we compared the surgical outcomes between the PESS and RESS groups for CRSwNP and evaluated the impact of prior ESS on RESS outcomes. Patients' subjective reports are regarded as an essential indicator of the disease severity and treatment efficacy because CRS is still predominantly diagnosed based on symptoms and evidence of mucosal inflammation. Endoscopic findings and CT appearance are used to evaluate CRS objectively. The SNOT-22 questionnaire, endoscopic findings based on the LK score, CT appearance based on the LM score, and polyp grading system were all employed in this study to assess the subjective and objective outcomes. As determined by the SNOT-22 measurements, patients in the 2 groups showed significant improvement in their subjective symptoms at the 6-month follow-up, but did not differ statistically in both groups. Endoscopic physical findings by the LK score in the 2 groups of patients showed significant improvement in terms of polyp grades, discharge, and edema. At 6 months postoperatively, about 60% to 70% of patients in both groups had clear sinus mucosa without polyps, and 35% to 45% of patients had no discharge, while edema improved by about 10% in the RESS group. These results imply that the PESS and RESS groups achieved essentially successful surgical outcomes, with the PESS group achieving greater success than the others. Several studies supported our findings in this regard.[29,40–44] These studies used SNOT-20, which was statistically significant,[40] while the Claire Hopkins study used SNOT-22 with a follow-up of 5 years and showed similar results to our study.[43]

The remaining 2 parameters used in this study were the LM score and the polyp grading system. The LM score showed a significant difference between the 2 groups in this study, 15.87 and 18.39, respectively; ($P < .001$). This is similar to the study by Clinger et al,[45] in which a highly significant difference was reported. Regarding the

Table 3. A Comparison of SNOT, LM, and LK Scores in Primary and Revision ESS for CRSwNP (Using Independent *t*-Tests for Quantitative Variables).

Item	Primary M (± SD)	Revision M (± SD)	*t*-statistic	*P*-value
SNOT22 pre-op	34.87 (± 27.43)	40.14 (± 15.02)	0.58	.568
SNOT22 post-op	22 (± 19.79)	29.08 (± 19.79)	0.99	.328
LK pre-op Rt.	2.44 (±1.198)	2.72 (± 1.121)	2.426	.016
LK pre-op Lt.	2.45 (±1.198)	2.62 (± 1.146)	1.439	.151
LK pre-op total	4.88 (±2.230)	5.32 (± 2.145)	1.985	.048
LK post-op Rt.	0.66 (±0.984)	1.09 (± 1.180)	3.843	.000
LK post-op Lt.	0.63 (±0.952)	1.02 (± 1.174)	3.588	.000
LK post-op total	1.29 (±1.833)	2.12 (± 2.244)	3.915	.000
LM pre-op Rt.	7.89 (± 3.2)	9.23 (± 2.78)	4.23	.000
LM post-op Rt.	5.77 (± 3.05)	5.94 (± 2.91)	0.26	.790
LM pre-op Lt.	7.98 (± 3.10)	9.2 (± 2.93)	3.99	.000
LM post-op Lt.	5.57 (± 3.28)	5.90 (± 2.84)	0.53	.593
LM pre-op total	15.87 (± 6.12)	18.39 (± 6.07)	4.10	.000
LM post-op total	11.85 (± 5.64)	11.51 (± 6.01)	0.59	.555
CT duration after surgery (years)	1.72 (± 1.44)	1.44 (± 1.23)	0.941	.349

SD, standard deviation; SNOT22 pre-op, SNOT22 preoperatively; SNOT22 post-op, SNOT22 postoperatively; LK pre-op, Lund–Kennedy preoperatively; LK post-op, Lund–Kennedy postoperatively; LM pre-op, Lund–Mackay preoperatively; LM post-op, Lund–Mackay postoperatively; Rt., right side; Lt., left side.

polyp grading system, we found that the polyp grade in the PESS group improved by approximately 50%, which is more than that of the RESS group. Additionally, in our study, the history of asthma, aspirin sensitivity, Samter's Triad, NP, and older age were identified as significant determinants of revision surgery, and this is similar to previous studies.[1,28,42,43,46]

Furthermore, ESS is frequently carried out along with other surgical operations such as turbinoplasty or septoplasty. In our study, ESS combined with septoplasty was performed on 64% of the population. Likewise, according to the literature, septoplasty is typically performed more frequently in primary sinus surgery than in revision surgery, primarily for anatomic and surgical reasons.[47,48] Moreover, prior research has demonstrated that patients who underwent ESS with septoplasty had considerably lower revision rates than those who underwent ESS alone, which may be due to narrower routes impairing mucociliary clearance.[47,48]

Although previous studies showed no statistically significant differences between the QOL outcomes of PESS patients and RESS patients, our study found that the QOL of PESS patients improved significantly more than that of RESS patients. However, the patient populations in those earlier studies (119 and 238) were smaller, and there was a tendency for PESS patients to have better QOL outcomes.[29,30]

Several limiting factors exist in this study, despite its substantial cohort size and the identification of significant factors associated with the need for revision surgery in patients with CRS. Primarily, the single-center study design poses a limitation. Moreover, the failure to consider endotype variations among CRS patients presents an additional

Table 4. A Comparison of Polyp Grading System in Primary and Revision ESS for CRSwNP (Pearson Chi-Square for Categorical Variables).

Item		Number of ESS			
		Total *N*	Primary No. (%)	Revision No. (%)	χ^2 (*P*-value)
Polyp grade pre-op Rt.	G 0	34	30 (9.6%)	4 (2.7%)	14.852 (.005)
	G 1	71	57 (18.3%)	14 (9.6%)	
	G 2	121	79 (25.3%)	42 (28.8%)	
	G 3	151	93 (29.8%)	58 (39.7%)	
	G 4	81	53 (17.0%)	28 (19.2%)	
Polyp grade pre-op Lt.	G 0	34	26 (8.3%)	8 (5.5%)	11.693 (.020)
	G 1	65	55 (17.6%)	10 (6.8%)	
	G 2	117	74 (23.6%)	43 (29.5%)	
	G 3	161	103 (32.9%)	57 (39.0%)	
	G 4	83	55 (17.6%)	28 (19.2%)	
Polyp grade post-op Rt.	G 0	316	224 (80.9%)	92 (71.9%)	8.180 (.085)
	G 1	54	32 (11.6%)	25 (19.5%)	
	G 2	23	13 (4.7%)	10 (7.8%)	
	G 3	8	7 (2.5%)	1 (0.8%)	
	G 4	1	1 (0.4%)	0 (0.0%)	
Polyp grade post-op Lt.	G 0	320	227 (81.9%)	93 (72.7%)	5.496 (.139)
	G 1	54	30 (10.8%)	24 (18.8%)	
	G 2	21	13 (4.7%)	8 (6.3%)	
	G 3	10	7 (2.5%)	3 (2.3%)	
	G 4	0	0 (0.0%)	0 (0.0%)	

ESS, endoscopic sinus surgery; pre-op, preoperatively; post-op, postoperatively; Rt., right side; Lt, left side.

constraint. To enhance the precision of forthcoming research, we recommend conducting multicenter studies, integrating eosinophil counts into the analysis, and contemplating longer follow-up periods to evaluate long-term outcomes.

Conclusion

This retrospective study demonstrated a significant postoperative improvement in both subjective and objective outcomes after ESS, indication that PESS is associated with better outcomes compared to RESS, as assessed by the SNOT-22 questionnaire, LK and LM scores, and polyp grading. The study also identified several risk factors, including the presence of asthma, aspirin sensitivity, Samter's Triad, high grade nasal polyps, and older age, which are associated with recurrence of CRSwNP that may requires RESS.

Declarations

Ethics Approval and Consent to Participate

This study received ethical approval from the Institutional Review Board Committee at the College

of Medicine, King Saud University (Approval No. E-22-6704). Identification data were not used in this study. Additionally, we ensured that all patients' personal information was protected and kept confidential. Consent for participation was not required due to the retrospective nature of this study.

Author contribution(s)

Ahmad Aldajani: Conceptualization; Investigation; Methodology; Writing – original draft; Writing – review & editing.
Ahmad Alroqi: Conceptualization; Resources; Supervision; Validation; Writing – review & editing.
Ali Alrashidi: Data curation; Formal analysis; Visualization; Writing – original draft.
Anas Alsaif: Data curation; Formal analysis; Investigation; Writing – original draft.
Saif Almeshari: Data curation; Formal analysis; Investigation; Writing – original draft.
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Saud Alromaih: Project administration; Resources; Visualization.
Mohammad O. Aloulah: Project administration; Resources; Visualization.
Abdulaziz S. Alrasheed: Project administration; Resources; Visualization.
Saad Alsaleh: Conceptualization; Resources; Supervision; Writing – review & editing.

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Conflict of Interest Statement

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Availability of Data and Materials

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

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