Effect of Functional Endoscopic Sinus Surgery on Bronchial Asthma Outcomes

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Background: For more than 70 years, the coexistence of asthma and paranasal rhinosinusitis has been noted in the medical literature. Causal relationships have been proposed but not proved. To date, limited evidence exists suggesting that asthma improves after surgical correction of rhinosinusitis.

Objective: To determine whether asthma control improved after first-time functional endoscopic sinus surgery (FESS).

Patients and Methods: A retrospective medical record analysis was performed on 13 patients with chronic bronchial asthma who underwent FESS for medically refractory chronic rhinosinusitis. Patients received comprehensive asthma care before and after FESS (mean, 19.3 and 33.1 months, respectively). Outcomes analyzed included pre- and post-FESS individual and group mean asthma symptom scores, medication use scores, pulmonary function test results, and emergency department visits or hospital admissions for asthma. Patient medical records were obtained from a private allergy-immunology practice affiliated with a medical school. The surgical procedure was performed at a tertiary care teaching hospital by a single ear, nose, and throat surgeon (R.L.).

Results: Following FESS, there was no statistically significant change in group mean asthma symptom scores, asthma medication use scores, pulmonary function test results, and the number of emergency department visits or hospital admissions. Only a few patients demonstrated statistically significant improvement after FESS in asthma symptom scores (1 patient), medication use scores (1 patient), or pulmonary function test results (2 patients).

Conclusions: The data do not support the hypothesis that first-time FESS for medically refractory chronic rhinosinusitis in adult patients with chronic asthma leads to reduced postoperative asthma symptoms or asthma medication use or improved pulmonary function. Based on this limited study, a reexamination of the benefits of sinus surgery to coexisting asthma is in order.


C HRONIC rhinosinusitis and bronchial asthma independently are common respiratory tract conditions in the United States and are estimated to have a prevalence of 32 million and 9 to 12 million, respectively.1 Although the coexistence of sinus disease and bronchial asthma was first noted as far back as the second century AD by Galen,2 it was not until 1925 that a causal connection was postulated.3 Since then, several retrospective studies examining the concurrence of rhinosinusitis in patients with asthma have claimed that rhinosinusitis and asthma not only coexist but are pathogenically linked.3,3

Several pathogenic relationships have been proposed, including the presence of a nasal-bronchial reflex that originates in the nose and paranasal sinuses; postnasal secretion of infectious or inflammatory materials or both, that seeds the lower airways; the systemic effects of upper airway paranasal sinus mediators on the lower airways; nasal obstruction and mouth breathing that leads to the inhalation of cold, unfiltered air; the reduction of β-agonist responsiveness due to sinus infection; and sinus secretions that stimulate extrathoracic airway receptors, which in turn provoke lower airways irritability.3,3

Many conflicting reports from animal models and human studies have supported or rejected these theories.3,4 In addition, many studies have reviewed the effects of medical and surgical treatments
PATIENTS AND METHODS

Fifty patients were identified who had undergone first-time FESS by 1 ear, nose, and throat (ENT) surgeon (R.L.) from January 1987 to March 1995 and who were concomitantly managed by a medical school–affiliated private allergy-immunology practice (M.F.G., D.J.D., and E.H.D.). The FESS procedure was performed under general anesthesia by the technique described by Kennedy et al.7 Of 50 patients treated concomitantly for asthma and rhinosinusitis, 13 satisfied the following study inclusion criteria:

• Aged 18 years or older.
• No prior paranasal sinus, nose, or throat surgery.
• Preoperative asthma management by an allergist for at least 6 months.
• Postoperative asthma management by an allergist for at least 6 months.
• Postoperative ENT care by 1 ENT surgeon for at least 6 months.
• The patient had medically refractory chronic rhinosinusitis at the time of surgery. Chronic rhinosinusitis was diagnosed by criteria by Shapiro and Rachelefsky,8 with patients having undergone a minimum of 3 months of oral antibiotic therapy without computed tomographic resolution of chronic rhinosinusitis.
• The histopathologic appearance of diseased sinus mucosa and submucosa (excluding polyps) is consistent with chronic bacterial rhinosinusitis at the time of surgery.
• No underlying immunodeficiencies, cystic fibrosis, bronchiectasis, chronic obstructive pulmonary disease, diabetes mellitus, neoplasia, or fungal rhinosinusitis.

Nine of the 13 patients had nasal polyposis, 1 patient was a current smoker. Eleven patients had concurrent upper respiratory tract allergy confirmed by conventional prick and intradermal skin test responses to common aeroallergens—dust mites, pollens, molds, and animal dander.

Patients included in the study were classified as having moderate asthma and received conventional treatment with combination bronchodilator or anti-inflammatory medications, consistent with National Heart, Lung, and Blood Institute guidelines.9,10 Patients were evaluated every 1 to 3 months before and after surgery for their asthma in an allergist’s office. They were seen by the ENT surgeon every 1 to 2 weeks postoperatively until healed and then every 1 to 3 months thereafter. The allergists’ evaluations included symptoms, physical examination, medication use, spirometric PFTs, and review of any emergency department visits or hospital admissions for asthma. An increase or reduction in asthma medication use was predicated on reported symptoms, physical examination findings, or changes in PFT results (or a combination of these). Postoperative nasal endoscopy and sinus imaging were carried out by either the allergists or the ENT surgeon as deemed appropriate.

Post-FESS surveillance for recurrent polyposis, rhinosinusitis, and asthma control was routinely performed by the allergists and the ENT physician. Appropriate use of antibiotics for rhinosinusitis and changes in treatment of the upper or lower (or both) Airways were made based on these evaluations.

SYMPTOM SCORE

To date, there is no validated symptom score instrument used to assess asthma outcomes.11 Consequently, a symptom score was developed to identify asthma symptoms before and after FESS. Three common symptoms of asthma—

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 RESULTS

Thirteen patients were identified from a group of 50 patients with comorbid chronic asthma and medically refractory chronic rhinosinusitis who underwent FESS for the first time. The 13 patients were observed for bronchial asthma and chronic rhinosinusitis by the allergist(s) for a mean of 19.3 months (range, 6-56 months) before surgery and postoperatively for a mean of 33.1 months (range, 6-66 months). There were no emergency department visits or hospital admissions for asthma in the study population either before or after FESS. Nevertheless, in 5 of 9 patients who originally had nasal polyposis, recurrent nasal polyp disease developed in 3 patients within 6 months of FESS and in 2 patients 6 months after FESS. In 3 of these 5 patients, recurrent rhinosinusitis also developed that required revision FESS in addition to polypectomy. These patients had polypoid changes in their sinus mucosa originally reported and were also found to have polypoid changes in their sinus mucosa at the time of the revision FESS. One patient who did not have polypoid changes had recurrent rhinosinusitis that was un-

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cough, shortness of breath, and wheeze—were identified from progress notes for each patient’s before- and after-FESS office visits to the allergist. The presence or absence of each symptom was assigned the relative value of 1 or 0, respectively. An aggregate symptom score was recorded for each patient for each visit, and the mean symptom score was computed for all of the before- and after-FESS office visits (Table 1). The change in the mean symptom scores was computed for each patient. In addition, a mean change in before-and-after-FESS asthma symptoms for the entire study sample was computed (Table 2).

MEDICATION USE SCORE

A medication use score was developed to track the use of asthma medical therapies before and after FESS. Each drug used in the treatment of asthma was assigned a relative point value (Table 3). Dosing schedules were taken into account in developing the relative point value. Higher point values were assigned to drugs that represented a more intensive intervention.

Individual patient aggregate point values for medicine use for each visit were determined, and a mean score was computed for the presurgical and postsurgical periods (Table 1). Changes in the mean medicine use scores were then determined for each patient and a mean change in medicine use score for the entire sample population before and after FESS (Tables 1 and 2).

PULMONARY FUNCTION TESTING

Pulmonary function tests, including forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁), and the midexpiratory phase of the forced expiratory flow (FEF₂₅₋₇₅%), were measured at each pre- and post-FESS office visit using a spirometer that met American Thoracic Society standards (Spirometrics Inc, Auburn, Me). Volume-time curves and flow-volume curves were generated by standard techniques with each patient in a sitting position. Patients were vigorously instructed to produce a hard, fast, and long forced expiration for at least 6 seconds or as long as possible, consistent with American Thoracic Society criteria. The PFT data were expressed in absolute terms and as a percentage of predicted normal values. Mean FVC, FEV₁, and FEF₂₅₋₇₅% values were determined for each patient for the preoperative and postoperative periods (Table 4). The change in each mean PFT result before and after FESS was then computed for the entire sample population and for each patient (Tables 2 and 4).

STATISTICAL ANALYSIS

Descriptive analysis was used to characterize and compare the individual and group mean scores regarding asthma symptoms, asthma medication use, PFT results before and after FESS, and emergency department visits or hospital admissions for asthma. Individual mean scores before and after FESS were statistically compared for significance using the general linear model procedure of a commercially available software package (SAS/PC, Version 6.11, SAS Institute, Inc, Cary, NC). The P values were calculated based on a Student’s t test comparing the before- and after-FESS asthma symptom scores; asthma medication use scores; and FVC, FEV₁, and FEF₂₅₋₇₅% values (Tables 1 and 4). A group mean for each pre- and post-FESS value was obtained by calculating the mean of the individual values of the 13 subjects. A Student’s t test was calculated from the differences in the group means before and after FESS (Table 2). The level of significance was .05.

The individual changes in mean asthma symptom scores, medication use scores, and PFT results are shown in Tables 1 and 4. Six patients (patients 2, 4, 5, 10, 12, and 13) had a mean decrease in their symptom scores, with only patient 10 having a statistically significant decrease in the symptom score (P = .01) (Table 1). Three patients (patients 3, 6, and 12) had a mean decrease in their medication use, but only 1 patient (patient 12) had a statistically significant decrease in the mean medication score (P = .04) (Table 1). Four patients (patients 5, 8, 11, and 13) had an increase in their mean FVC value, ranging from 0.15 to 0.30 L, but these increases were not statistically significant improvements (Table 4). Five patients (patients 5, 8, 9, 11, and 13) had an increase in their mean FEV₁ from 0.04 to 0.88 L (Table 4). Only 2 patients (patients 5 and 11) had a statistically significant improvement (P = .01 and P = .02, respectively) in their mean FEV₁ (Table 4). Seven patients (patients 2, 4, 5, 8, 9, 11, and 13) showed improvement in their mean FEF₂₅₋₇₅% from 0.02 to 2.74 L/sec, but only 1 patient (patient 11) demonstrated statistically significant improvement (P = .005) (Table 4). No patient had statistically significant improvement in all 3 PFT values. The P values for these individual comparative differences, using a Wilcoxon rank sum test (results not shown), showed consistent results with an analysis of variance.

Group mean asthma symptom scores, asthma medication use scores, and PFT measurements were determined before and after FESS (Table 2). Comparative group mean data of these 5 variables before and after FESS revealed that first-time FESS did not lead to significant improvement in postoperative asthma symptoms (P = .72), asthma medication use (P = .82), or in the PFT values assessed—FVC: P = .54; FEV₁: P = .92; and FEF₂₅₋₇₅%: P = .67.

COMMENT

Comorbid chronic rhinosinusitis and bronchial asthma are commonly seen in both children and adults in the United States. Whereas each condition represents a common independent medical problem, allergists and otorhinolaryngologists have suggested causal links between chronic rhinosinusitis and bronchial asthma. Improvements in bronchial asthma have been suggested, but not conclusively demonstrated, in trials using aggressive medical
or non-FESS surgical approaches (or both) to chronic rhinosinusitis.3,4 Many of these studies were performed in children.3,4 During the past 12 years, FESS has been successfully used as a more physiological surgical approach to the treatment of medically refractory rhinosinusitis.4,6 Many studies have shown symptomatic and radiographic improvement of sinus disease by FESS in 76% to 87.5% of patients observed 1 to 3 years after the operation.6,13,14 More recent pediatric studies have suggested asthma improvement after FESS.15-19 Reports of the effects of FESS on asthma outcomes in adults have been limited.20,22

Our retrospective analysis examines the effect of initial FESS on bronchial asthma outcomes in adult patients (aged 18 years and older) with medically refractory chronic rhinosinusitis. Because FESS is considered a more physiological approach than non-FESS sinus operations, we had anticipated equal or improved asthma outcomes compared with those anecdotally reported in adults with non-FESS surgical techniques. We evaluated improvement in asthma based on mean changes in asthma symptom scores, asthma medication use scores, PFT results, and emergency department visits or hospital admissions for asthma before and after the operation. Each patient was evaluated and managed for at least 6 months before and after surgery. We examined individual and group mean preoperative and postoperative asthma symptom scores, asthma medication use scores, and pulmonary function study results. No statistically significant postoperative improvements were observed in 59 of 70 individual comparisons and 5 of 5 group comparisons.

The absence of asthma improvement was unlikely to be related to poor asthma management or lack of follow-up care of these patients. Patients included in this study were thoroughly evaluated and comprehensively treated for asthma in a manner consistent with national guidelines. The medical records document that patients treated for asthma before the publication of the National Heart, Lung, and Blood Institute guidelines in 1991 consistently received anti-inflammatory medications in

### Table 1. Individual Differences in Mean Asthma Symptom Scores and Mean Asthma Medication Use Scores Before and After FESS*

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Visits, No.</th>
<th>Before</th>
<th>After</th>
<th>Before</th>
<th>After</th>
<th>Difference†</th>
<th>P</th>
<th>Before</th>
<th>After</th>
<th>Difference†</th>
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<td>13</td>
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<td></td>
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<td>9</td>
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<td>15</td>
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<td></td>
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<td>.04</td>
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<td>3</td>
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<td>2.00</td>
<td>−0.75</td>
<td>.24</td>
<td></td>
<td>2.25</td>
<td>3.00</td>
<td>0.75</td>
<td>.24</td>
</tr>
</tbody>
</table>

*FESS indicates functional endoscopic sinus surgery. In all cases, “Before” and “After” refer to FESS.
†Difference indicates the after-FESS score minus the before-FESS score.

### Table 2. Group (N = 13) Differences in Mean Asthma Symptom Scores, Mean Asthma Medication Use Scores, and Mean Pulmonary Function Test Measurements Before and After FESS*

<table>
<thead>
<tr>
<th>Variable†</th>
<th>Mean Scores</th>
<th>Before</th>
<th>After</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom scores</td>
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<td>2.26</td>
<td>2.36</td>
<td>.72</td>
</tr>
<tr>
<td>Medication use scores</td>
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<td>3.69</td>
<td>3.85</td>
<td>.83</td>
</tr>
<tr>
<td>FVC, L</td>
<td></td>
<td>3.60</td>
<td>3.41</td>
<td>.54</td>
</tr>
<tr>
<td>FEV₁, L</td>
<td></td>
<td>2.68</td>
<td>2.65</td>
<td>.92</td>
</tr>
<tr>
<td>FEF₂₅₋₇₅, L/s</td>
<td></td>
<td>2.42</td>
<td>2.62</td>
<td>.67</td>
</tr>
</tbody>
</table>

*FESS indicates functional endoscopic sinus surgery. "Before" and "After" refer to scores obtained before and after FESS.
†FVC indicates forced vital capacity; FEV₁, forced expiratory volume in 1 second; and FEF₂₅₋₇₅, midexpiratory phase of the forced expiratory flow.

### Table 3. Relative Point Values for Dosing Schedules of Asthma Medications

<table>
<thead>
<tr>
<th>Drug and Dosing Frequency*</th>
<th>Relative Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-needed β₂-agonist therapy</td>
<td>0.5</td>
</tr>
<tr>
<td>Scheduled daily β₂-agonist therapy</td>
<td>1.0</td>
</tr>
<tr>
<td>Scheduled daily theophylline anhydrous</td>
<td>1.0</td>
</tr>
<tr>
<td>Scheduled daily ipratropium bromide</td>
<td>1.0</td>
</tr>
<tr>
<td>Scheduled daily conventional dose inhaled</td>
<td>1.0</td>
</tr>
<tr>
<td>nedocromil or cromolyn sodium, up to</td>
<td>1.0</td>
</tr>
<tr>
<td>maximal FDA-recommended total dosage†</td>
<td></td>
</tr>
<tr>
<td>Scheduled daily inhaled glucocorticosteroids, up to</td>
<td>1.0</td>
</tr>
<tr>
<td>maximal FDA-recommended total dosage‡</td>
<td></td>
</tr>
<tr>
<td>Oral glucocorticosteroids burst therapy, ≤ 5 days</td>
<td>1.0</td>
</tr>
<tr>
<td>Scheduled daily high-dose inhaled glucocorticosteroids§</td>
<td>1.5</td>
</tr>
<tr>
<td>Scheduled alternate-day oral glucocorticosteroids</td>
<td>1.5</td>
</tr>
<tr>
<td>Scheduled daily oral glucocorticosteroids</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*FDA indicates US Food and Drug Administration.
†Nedocromil sodium, ≤ 14 mg/d; cromolyn sodium, ≤ 6400 µg/d.
‡Beclomethasone dipropionate, ≤ 840 µg/d; flunisolide, ≤ 2000 µg/d; and triamcinolone acetonide, ≥ 1600 µg/d.
§Beclomethasone dipropionate, > 840 µg/d; flunisolide, > 2000 µg/d; and triamcinolone acetonide, > 1600 µg/d.
addition to bronchodilator treatment and antiallergic regimens. This reflects most specialists’ knowledge of asthma, even before the publication of national guidelines, as an inflammatory airway condition. At each allergist follow-up visit, decisions were made to reduce or increase asthma medications based on symptom reports, physical examination findings, or PFT values. Our study varies in this regard from previously reported studies in 2 important respects. Most of the previously reported studies were performed and reported before the institution of national and international practice guidelines for the treatment of asthma and before the general medical community’s awareness of asthma as an inflammatory condition of the airways. As such, asthma care before sinus surgery (non-FESS and FESS) did not consistently include the use of maintenance anti-inflammatory treatment, antiallergy avoidance or treatment, or both. The lack of such treatment has been associated with increased asthma severity.23 In addition, in most studies, primary care physicians were responsible for asthma management before and after the operation. Many studies have documented that compliance with accepted national or international guidelines for asthma management is poorest among generalists and that expert care by asthma specialists improves asthma outcomes.24 It is possible that previously reported reductions in asthma after medical or surgical treatment of rhinosinusitis were due in part to poorly controlled baseline asthma and that optimization of anti-inflammatory and antiallergy treatments for asthma before the operation may mitigate the role of inflammatory sinus disease in exacerbating asthma. In our group of patients, with maintenance anti-inflammatory and antiallergy therapies, the removal of sinus triggers may, therefore, have had less effect on asthma symptoms, medication use, and PFT values than in asthmatic patients not controlled with such treatments.

In our study, variation in surgical techniques and operative results was limited by having all patients surgically treated by 1 ENT surgeon (R.L.). The success of the surgery was assessed by the postoperative presence or absence of sinus symptoms, surveillance sinus imaging, postoperative endoscopic evaluations (or a combination of these). These studies were performed periodically based on clinical judgment to confirm or rule out the presence of recrudescence rhinosinusitis, nasal polyposis, or poorly controlled allergic rhinitis. When recurrent rhinosinusitis was identified, patients were aggressively treated with antibiotics and adjuvant therapies. Most patients had infrequent recurrent rhinosinusitis that resolved with treatment. During our study, 4 patients had resistant recurrent rhinosinusitis that ultimately required revision endoscopic surgery, polypectomy, or both. This represents a higher rate (31%) of subsequent revision surgery than previously reported (7%-10%).6,13-15 Because many of our patients were diagnosed as having pansinusitis and nasal polyposis initially, a higher recurrence rate is expected with these last conditions.4

In addition, several other factors may explain why we were not able to demonstrate improvement in asthma outcomes after FESS. First, this was a small study with a limited group of highly selected patients fulfilling restrictive inclusion criteria. A larger study group would have more power to discriminate distinctions before and after FESS. Second, our patients had a high incidence of upper respiratory tract allergies (11 of 13 patients), nasal polyposis (9 of 13 patients), and chronic (not new-onset) asthma (13 of 13 patients), which may have biased the group to being more resistant to asthma improvement even after surgical interventions.3 Third, we limited our outcome evaluation to 4 variables: asthma symptom scores, asthma medication use scores, PFT values, and emergency department visits or hospital admissions for asthma. The severity of symptoms was not delineated: distinctions were not made between nocturnal and daytime symptoms or the severity of symptoms based on awakening and interference with activities or restriction of daily routines. A more precise symptom evaluation and a less arbitrary medication use score may have helped discriminate changes in asthma symptoms and medication use before and after FESS; however, validated asthma symptom scores and asthma medication use scores are not currently available.15 A validated asthma-
specific quality-of-life questionnaire, assessment of airways hyperreactivity, and sputum specimen analysis may also have added more sensitive outcome measurements to assess statistically significant improvement. During this retrospective study, however, quality-of-life instruments were not incorporated in routine clinical practice. Last, our patients may represent a subset of patients with asthma without a presumed sinonasal-bronchial reflex for whom sinus surgery would not be expected to improve asthma outcomes. Such patients have been mentioned in the literature.

Although FESS is highly effective for medically refractory chronic rhinosinusitis, as reported in the literature and in our series, its role in lessening the severity of chronic asthma is less clear. Despite the shortcomings of our study, our observations challenge the validity of the hypothesis that long-term asthma control may improve after first-time sinus surgery. Patients and physicians should have clear expectations about the effects of FESS on the course of chronic bronchial asthma. Furthermore, surgical remedies for rhinosinusitis should be recommended for anticipated lessening of sinus symptoms and not improvements in asthma outcomes.

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