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Objective assessment of endoscopic sinus surgery in the management of chronic rhinosinusitis: an update

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Abstract

Whilst clinical success of endoscopic surgery for chronic rhinosinusitis has necessarily depended primarily upon subjective evaluation, a range of objective techniques are now available which may facilitate our interpretation of results. A group of 200 patients underwent assessment of symptoms by sequential visual analogue scoring, olfaction by qualitative and quantitative testing, nasal airflow by forced inspiratory peak flow, anterior rhinomanometry, nasomucociliary function by ciliary beat frequency and nasal topography by acoustic rhinometry performed pre- and post-operatively. Significant improvement was demonstrated in all symptoms examined, olfactory tests and ciliary beat frequency whilst acoustic rhinometry provided an attempt to quantify the surgical cavities. These results offer an interesting perspective on the pathology of rhinosinusitis and the rationale for surgery within the ostiomeatal complex.

Key words: Surgery, endoscopic sinus; Results, objective

Introduction

In 1991, our initial attempts at quantifying the results of endoscopic sinus surgery in the management of chronic rhinosinusitis were published (Lund *et al.*, 1991), suggesting that there was some genuine improvement in sinus pathophysiology following surgery, which supported the clinical claims made by exponents of the technique. Since that time, a number of studies have appeared in the literature but virtually all have presented subjective results, with or without correlation to endoscopic findings (Stammberger, 1991; Kennedy, 1992). The patient's own perception of clinical improvement may indeed represent the 'bench-mark' for a condition which does not have an obvious end point like cancer but it is important to consider ways of objectively documenting the impact, if any, of any therapeutic strategy. To this end, a larger group of patients has been considered, assessed pre- and post-operatively with a number of objective tests.

Methods

Patients

Two hundred patients attending the Rhinology Research Clinic with symptoms of chronic rhinosinusitis for three months or longer who had consecutively undergone endoscopic sinus surgery were entered in the study. All patients had failed appropriate conservative medication which included intranasal steroids, antibiotics, antihistamines and specific allergen avoidance where appropriate. All patients had skin prick tests performed to 10 common allergens (with negative and positive control) and underwent haematology tests to exclude relevant systemic disease and immune deficiency. Patients with gross polyposis, congenital defects of mucociliary function and gross immune deficiency were excluded. All patients underwent rigid endoscopy of the nasal cavity pre- and post-operatively and computerized tomography was performed at the point when medical therapy had failed, prior to surgery.

Subjective assessment

The clinical symptoms were assessed on a 0–10 visual analogue scale (VAS) which considered nasal obstruction, problems with the sense of smell, anterior nasal discharge, post-nasal discharge, facial pain and headache. An overall mean score of 5 or more was necessary for inclusion in the study. The quality of the discharge was noted and was mucopurulent in all cases.

Objective assessment

Mucociliary function was assessed by measurement of ciliary beat frequency, using the technique described by Rutland *et al.* (1982) in which a brushing is taken from approximately 1 cm behind the anterior end of the inferior turbinate using a bronchoscopic cytology brush. The measurement is done using a photometric technique employing a Leitz Dialux 20 microscope to which a Leitz MPV compact microscope photometer is connected. The readings are done at × 320 magnification. A rectangular light (1.5 × 5μm) from the photometer is positioned in the long axis of the cilia so that it is interrupted by ciliary beating. The change in light intensity is transformed into an electrical signal which is then converted to a reading in

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hertz or beats/second by a ciliary frequency processor unit (Greenstone *et al.*, 1984). Ten readings were made on each specimen within one hour of the specimen being taken and the mean calculated. The normal range is 12–15 Hz. All readings were done without prior knowledge of the surgical status of the patient.

Olfactory function

Olfactory threshold determination was determined using a set of polypropylene squeeze bottles containing serial dilutions of pm-carbinol in mineral oil (Amoore, 1992). The patient was asked to distinguish between the bottle containing the active ingredient and a control bottle containing only diluent. A point is reached where it is not possible to distinguish between the two, which is regarded as the olfactory threshold for that individual. The range is −5 to > +55 decismels, with −5 to +25 being the normal range.

Qualitative suprathreshold testing of olfaction was performed using a University of Pennsylvania Smell Identification Test (UPSIT). The patient was asked to 'scratch and sniff' a patch containing microencapsulated particles of odorant. They then must choose between four possible odours, even if they are only able to guess. The test has been validated for age, sex, and repeatability and produces a score of 0 to 40 (Doty *et al.*, 1984), with >34 being the normal adult range.

Tests of nasal airway

Nasal inspiratory peak flow (NIPF) was performed using a modified peak flow meter (Youlten, 1980) and the best of three maximal efforts recorded.

Anterior active rhinomanometry was performed using a standardized technique after the method of Jones *et al.* (1987) (using a Mercury NR6D rhinomanometer) and a value for total nasal airway resistance considered.

Acoustic rhinometry

This relatively new technique offers topographical information on the nasal cavity by generating a plot of nasal cross-sectional area against distance from the nose using acoustic equipment and computer software developed by Hilberg *et al.* (1989). An audible sound (150–10 000 Hz) produced by a spark generator is introduced into the nasal cavity via a perspex nosepiece. The reflections of this sound from the nasal cavity are received in a microphone and analysed by computer software to generate a plot of nasal cross-sectional area as a function of distance from the nosepiece on a log scale (Grymer *et al.*, 1991). From this plot, volumes between various distances into the nasal cavity (and minimal cross-sectional area) may be derived. An average of three measurements is taken in each nostril before and after decongestion. For the purposes of this study the nasal volume at distances between 6.9–14.1 cm and 9.0–14.8 cm were considered using a Bruel and Kjaer machine.

Surgical technique

Surgery was performed in all cases under general anaesthesia by one surgeon using the technique essentially as described by Stammberger (1985). The extent of the surgery was determined by the extent of the disease but included uncinectomy, anterior ethmoidectomy and perforation of the ground lamella of the middle turbinate in all cases, with posterior ethmoidectomy, sphenoidectomy, clearance of the frontal recess and enlargement of the maxillary ostium as required. (Ninety-two per-cent underwent middle meatal antrostomy at the site of the natural ostium).

Patients continued with intranasal steroid therapy up to the time of surgery and for at least three months post-operatively. Antibiotics were given after surgery if purulent secretion was present (usually erythromycin 500 mg tds for 10 days).

All patients were reviewed regularly following surgery to perform endoscopic cleaning of the ethmoidal cavities. This was done initially between five and 10 days after surgery and thereafter at one to two weekly intervals until the cavities were satisfactorily healed. Twelve patients (six per cent) underwent revision endoscopic surgery within the first year of follow-up, generally between three and six months. No patient subsequently underwent inferior meatal antrostomies or Caldwell-Luc approaches. There were no complications during or following surgery in this study group other than occasional adhesion formation within the middle meatus and closure of the middle meatal antrostomy on one or both sides in five individuals.

Results

There were 109 men and 91 women, their ages ranging from 18 to 83 years (mean 47 years). The majority were non-smokers (84 per cent). Fifty-nine per cent had had one or more positive skin tests. Fifty-eight per cent had undergone previous surgery, with between one and six procedures (mean 2.2). This included inferior meatal antrostomy (25 per cent), septal surgery (25 per cent), intranasal polypectomy (20 per cent), inferior turbinate reduction (18 per cent), Caldwell-Luc procedures (5 per cent) and external ethmoidectomy (2.5 per cent).

Follow-up ranged from one to four years (mean 2.3 years). The patients were evaluated subjectively and objectively immediately prior to surgery and used visual analogue scores at each of their post-operative visits. The results used in this analysis were those taken at one year in all cases. The objective tests were performed when the surgical cavities had satisfactorily healed, usually at around three months.

The results of the visual analogue symptom scores (VAS) are shown in Table I. All symptoms as assessed on the mean VAS, were significantly improved following surgery ($p<0.05$). Ciliary beat frequency was available pre- and post-operatively in 65 individuals and the mean value showed a significant improvement ($p<0.05$) (Table II).

Olfaction was specifically considered in hyposmic individuals, which for the purposes of this study, was defined as having an initial UPSIT score of 30 or less and constituted a subgroup of 50 patients. VAS, UPSIT and olfactory thresholds all showed a significant improvement in mean values (Table II).

Neither the mean nasal inspiratory peak flow (NIPF) nor total nasal airway resistance (TNAR) which were both available in twenty patients pre- and post-operatively

TABLE I
RESULTS OF ENDOSCOPIC SINUS SURGERY: VISUAL ANALOGUE SCORES (VAS)

Symptoms	Pre-operative mean VAS (0–10)	Pre-operative mean VAS (0–10)	Difference in mean pre-/post-operative scores	SD
Smell	5.3	2.6	2.7*	± 3.5
Obstruction	5.5	2.4	3.1*	± 3.6
Anterior discharge	4.5	2.4	2.1*	± 3.7
Postnasal discharge	5.8	3.6	2.2*	± 3.3
Facial pain	4.2	1.7	2.5*	± 3.3
Headache	5.2	2.5	2.7*	± 3.4

Number of patients = 200; * = $p<0.05$.

showed any significant change. Pre- and post-surgical acoustic rhinometry was compared in 26 cases between two and 23 months post-operatively (mean 5.2 months). After decongestion this showed a mean increase in volume of 3.5 cc between 6.9–14.1 cm ($p<0.005$) and 4.3 cc between 9.0–14.8 cm ($p<0.005$) (Figure 1). When the visual analogue score for the sensation of blockage (0–10) is considered in these patients at the time acoustic rhinometry was performed, it improved in 24 individuals (92 per cent) from between 2–10 (mean 5.4), and deteriorated by 1 in two individuals.

In 32 patients, the VAS were available for comparison at one year and four years. This showed that at the end of follow-up, 78 per cent had scores which were the same or lower when compared with those at one year.

Discussion

A large number of studies with variable follow-up have focused on the patients' subjective appraisal of results (Rice, 1989; Schaefer *et al.*, 1989; Hoffman *et al.*, 1990; Levine, 1990; Stammberger and Posawetz, 1990; Kennedy, 1992; Lazar *et al.*, 1993; Lund and Mackay, 1994) and have consistently shown a clinical improvement estimated at between 80–98 per cent but objective tests have not been performed. These results based on a large cohort of patients with a reasonable period of follow-up continue to support the contention that endoscopic sinus surgery addresses the pathophysiological problems underlying sinusitis and are in keeping with those of our previous preliminary study (Lund *et al.*, 1991).

The VAS offers a reproducible quantifiable evaluation of patients symptoms which may give more subtle information than simply asking if the patient is better, the same or worse and confirms overall clinical improvement for all clinical symptoms considered.

Patients are particularly aware of an improvement in their sense of smell, which the objective tests in the hyposmic group supported though it is noteworthy that the mean objective results did not move into the 'normal' range. The improvement may justifiably be ascribed to the surgery, as all patients had already been treated with intranasal steroids and continued with these after surgery. There are few studies applying objective olfactory tests to endoscopic sinus surgery. In our preliminary study, only a trend to objective improvement could be demonstrated, whereas Yamagishi *et al.* (1989) were able to demonstrate a 70 per cent subjective and an 80 per cent objective improvement using olfactometry and alinamine intravenous administration tests.

Unsurprisingly, despite a marked improvement in the sensation of nasal obstruction, tests of nasal airflow showed no significant change. As these largely consider change in the anterior valve region of the nose, one would not expect surgery in the middle meatus to have any major effect (Haight and Cole, 1983). Jones *et al.* (1989) have shown that there is no correlation between nasal resistance airflow as measured by anterior rhinomamometry and subjective sensation of airflow. It would seem likely that it is the inflammatory disease within the middle meatus which is primarily responsible for the sensation of 'congestion', which when removed surgically, produces a significant improvement in the VAS for obstruction. This may explain why a significant proportion of these patients had already undergone septal and turbinate surgery which had proved ineffective.

Acoustic rhinometry, in measuring topography rather than flow, confirms that surgery has been performed but

TABLE II
RESULTS OF OBJECTIVE TESTS FOR ENDOSCOPIC SINUS SURGERY

Test	Pre-operative Mean	Post-operative Mean	SD	Difference in mean pre-/post-operative result	Number of patients
CBF (H_z)	13.1	15.0	± 1.7	2.9*	65
NIPF (l/min)	155.0	150.0	± 2.0	5.0 (n.s.)	50
TNAR (Pa.s/cc)	0.27	0.26	± 0.02	0.001 (n.s.)	50
Hyposmics					
VAS	7.0	4.1	± 2.4	2.9*	50
UPSIT	19.5	25.0	± 5.1	5.5*	50
Olfactory threshold	50.0	35.0	± 14.0	15.0*	50

n.s. = not significant; * = $p<0.05$.
CBF: ciliary beat frequency.
NIPF: nasal inspiratory peak flow.
TNAR: total nasal airway resistance.
VAS: visual analogue score.
UPSIT: University of Pennsylvania Smell Identification Test.

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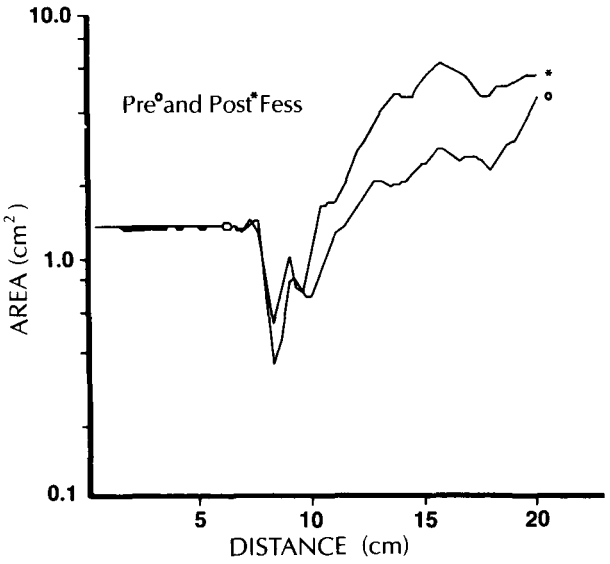

FIG. 1

Example of acoustic rhinometry pre- and post-endoscopic surgery.

also enables some quantification of that surgery to be made. The coefficient of variation in the decongested nose is considerably less than for rhinomanometry but may still be of the order of two per cent (Fisher *et al*: in press). There are in addition a number of other potentially complicating factors with the technique, most notably the signal loss which might occur through the middle meatal antrostomy. Studies are presently being conducted to resolve this, but any inaccuracy would be common to all cases since all patients considered had comparable procedures in terms of antrostomy size and preservation of the middle turbinate.

Ciliary beat frequency (CBF) was once again chosen in preference to the saccharine clearance test as it can detect more subtle changes with greater accuracy. CBF has been shown to decrease in response to a number of factors including the products of common respiratory tract pathogens (Read *et al.*, 1991; Feldman *et al.*, 1992). Although it is not possible to place too much emphasis on the improved ciliary beat frequency, it is noteworthy that there was a consistent increase in this measurement, when repeated on a number of occasions post-operatively, which may be interpreted as an indirect indication of reduced inflammation/infection within the nasal cavity as a whole. A more accurate measurement would be obtained from additional samples taken from the lateral side of the middle turbinate and this is now being considered.

Kennedy (1992) has drawn attention to the disparity which can exist between endoscopic appearances and patients' self-assessment. Furthermore, the observation has been made that patients in whom the endoscopic appearances suggest continued disease, despite a perception of clinical improvement by the patient, are individuals who are most likely to relapse in the future. It is therefore, encouraging to find that significant improvement was maintained during the four-year follow-up period in 78 per cent of 32 individuals in keeping with the observations of others (Stammberger, 1991; Schaitkin *et al.*, 1993).

An historical comparison between a prospective study of inferior meatal antrostomy and endoscopic sinus surgery has been previously discussed (Lund *et al.*, 1991; Lund and Mackay, 1993; Lund and Mackay, 1994) but it is worth emphasizing that over 25 per cent of this present group had already undergone conventional surgery (inferior meatal antrostomy, Caldwell-Luc or external ethmoidectomy), none went on to require these procedures and clinical success was maintained in the majority of those available for assessment at four years. The cynic might conclude that the patients did as well as they might have done with conventional surgery. This is not supported by an examination of individual symptoms nor have any satisfactory randomized trials been conducted to confirm this. Indeed, until a reliable staging system is employed, it will be difficult to avoid the criticism of failing to compare 'like' with 'like'.

In the meantime, these results lend support for the continued use of an endoscopic approach in the management of chronic rhinosinusitis, both on clinical physiological grounds.

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