Indian J Otolaryngol Head Neck Surg
(August 2013) 65(Suppl 2):S276–S282; DOI 10.1007/s12070-011-0432-2

ORIGINAL ARTICLE

Predictive Factors for a Good Outcome Following Endoscopic Sinus Surgery

P. Murthy · Sudipta Banerjee

Received: 6 June 2010 / Accepted: 20 December 2011 / Published online: 21 January 2012

Abstract The aim of this study was to establish if there are any symptoms which can predict increased patient satisfaction following Endoscopic Sinus Surgery (ESS) and whether these symptoms correlate with Lund-Mackay score on Computerised Tomography (CT). A prospective observational study was performed. Ninety-three consecutive patients who were offered ESS were recruited from an otolaryngology department in a UK Teaching Hospital. All patients had failed medical therapies for chronic rhinosinusitis (CRS), recurrent acute sinusitis and/or nasal polyposis. Patients were asked to complete a questionnaire pre-operatively and 12 months after surgery. Symptoms were assessed using a visual analogue scale. Endoscopic examination of the nose was performed pre and post-operatively. Lund-Mackay score was recorded for the pre-operative CT scan. Results were analysed using linear regression analysis and Pearson correlation coefficient. All symptoms improved after ESS ($P < 0.001$). However, a high pre-operative score for nasal discharge and olfactory disturbance were predictive of lesser improvement in symptom scoring ($P < 0.001$). Patients undergoing polypectomy with ESS demonstrated greater improvement in symptom score than those undergoing ESS with septoplasty or turbinate reduction surgery. There was no correlation between symptom score improvement and pre-operative Lund-Mackay score ($r = 0.09$). Patients who have high pre-operative symptom scores for nasal discharge and olfactory disturbance may gain less benefit from ESS, whilst those with nasal polyposis appear to perceive the greatest benefit. Increasing pre-operative Lund-Mackay score is not a predictor of a favourable operative outcome.

Keywords Endoscopic sinus surgery · Outcome · Lund-Mackay scoring system

Introduction

Chronic Rhinosinusitis (CRS) is a very common condition with patients presenting frequently to general practitioners and otolaryngologists. Whilst many patients can be managed with medical therapies including intranasal steroids and antibiotics, many will ultimately undergo surgery. In recent times, this has predominantly taken the form of endoscopic sinus surgery (ESS). Much has been published regarding the various aspects of ESS, including the outcome of national audits [1, 2]. The efficacy of ESS has been established by many studies of large numbers of patients [3–23]. The proportion of patients whose symptoms improved, range from 74 to 98%. In 1997, the Royal College of Surgeons of England published results of a National Audit of sinus surgery, which reported rates of improvement in nasal blockage of 84% and pain at 75% [1, 2]. However, clinical governance and a desire for enhanced patient satisfaction have led many to examine the possible predictors of a favourable outcome following endoscopic sinus surgery. This has included analysis of pre-operative symptoms and pre-operative computerised tomography (CT) scores, such as the Harvard or Lund-Mackay scoring systems. Many studies have found no

P. Murthy
Department of Otolaryngology and Head and Neck Surgeon, North Manchester General Hospital, Delaunays Road, Crumpsall, Manchester M8 6HD, UK

S. Banerjee (✉)
Department of Otolaryngology, Royal Oldham Hospital, Rochdale Road, Oldham OL1 2JH, UK
e-mail: sudipta.banerjee@pat.nhs.uk; sudi2071@yahoo.co.uk

correlation between pre-operative CT score and pre-operative symptoms [24], leading them to advocate that CT scanning should not be used as a means of diagnosis but more for delineation of anatomical features. However, the evidence for this is conflicting with some authors finding a correlation between CT scores and post-operative improvement in symptoms [25]. The result of this is that CRS remains largely a clinical diagnosis. This study was undertaken to assess whether certain symptoms or pre-operative CT scanning can be used to predict a good post-operative outcome, resulting in improved in patient selection.

Methods and Materials

Data was collected prospectively over a 4 year period. Ninety-three consecutive patients attending a UK teaching hospital otolaryngology department were recruited. Patients undergoing revision ESS and those under 16 years of age were excluded along with the following groups: patients with cystic fibrosis, immunodeficiency syndromes, fungal sinusitis, primary ciliary dyskinesia, sinonasal carcinoma and previous cocaine abuse. Patients with asthma and nasal polyposis were included. Patients who were undergoing additional surgery with ESS were included and these results analysed using linear regression. This additional surgery consisted of polypectomy, septoplasty or turbinate reduction surgery. The diagnosis of CRS was made according to the Rhinosinusitis task force of the American Academy of Otolaryngology-Head and Neck Surgery [26]. Symptom score was assessed using a 10-point visual analogue scale for the following symptoms: facial pain, nasal obstruction, nasal discharge (anterior and posterior), headache, olfactory disturbance and overall discomfort. These scores were then added to give a total symptom score, with a maximum score of sixty.

Patients were examined endoscopically and clinical features of septal deviation, mucopus, nasal polyposis and turbinate hypertrophy were recorded. CT scanning was performed pre-operatively and scored according to the Lund-Mackay scoring system. All patients had failed medical therapy and were not using any intranasal steroids or antibiotics pre-operatively.

All procedures were performed by one surgeon (PM) using the Messerklinger technique. Patients underwent septoplasty, polypectomy or turbinate reduction surgery if indicated. Post-operatively, patients were treated with intranasal steroids for 3 months and antibiotics for 7 days. Patients were asked to perform nasal douching with normal saline for 1 month post-operatively and reviewed 2 weeks following surgery for decrusting of the nasal cavity. No oral steroids were prescribed post-operatively.

Post-operative symptomatology was recorded at 4 and 12 months using the same 10-point visual analogue scale. Results were analysed using linear regression and Pearson correlation coefficient, using 'Stats Direct' Statistical package.

Results

93 patients were recruited initially, with 71 attending at 12 month post-operative review. Ten patients were contacted by telephone or letter and completed post-operative symptom questionnaires. This gave data available on 81 patients (87%). The remaining 12 patients were lost to follow-up.

The mean age of the patients was 48.3 years with a range of 21–73 years. There were 38 females and 43 males.

Fifty-eight (71%) underwent additional septoplasty along with ESS, 13 (16%) underwent additional endoscopic polypectomy and 7 (9%) had turbinate reduction surgery.

Mean Lund-Mackay score on CT was 9.1 (95% CI 7.8–10.4), with a range of 0–22. Fifteen patients were noted to have concha bullosa.

Table 1 illustrates the mean pre-operative and 12 months post-operative score for each symptom and the total symptom score. Figure 1 shows these figures illustrated on Box and Whisker plots.

Table 1 Mean Symptom scores and Total symptom score pre- and post-operatively

Symptom	Mean pre-operative score (95% CI)	Mean pos-operative score at 12 months (95% CI)	Mean of differences (Paired *t* test) (95% CI)	Statistical significance
Facial pain	5.45 (4.83–6.07)	2.17 (1.62–2.72)	3.24 (2.61–3.87)	$P < 0.0001$
Headache	3.10 (2.33–3.87)	1.46 (0.92–1.99)	1.58 (0.92–2.24)	$P < 0.0001$
Nasal obstruction	6.68 (6.17–7.19)	2.80 (2.22–3.38)	3.84 (3.16–4.51)	$P < 0.0001$
Nasal discharge	6.14 (5.49–6.78)	3.38 (2.76–4.00)	2.81 (2.16–3.46)	$P < 0.0001$
Smell disturbance	5.91 (5.25–6.56)	3.65 (2.91–4.40)	2.23 (1.53–2.94)	$P < 0.0001$
Overall discomfort	7.67 (7.31–8.03)	3.48 (2.85–4.11)	3.48 (2.85–4.11)	$P < 0.0001$
Total symptom score	34.95 (33.12–36.78)	16.70 (14.19–19.2)	18.04 (15.86–20.29)	$P < 0.0001$

It can be seen that the highest scoring symptom pre-operatively was nasal obstruction, followed by nasal discharge, olfactory disturbance, facial pain and finally headache. Nasal obstruction improved the most, with a mean reduction in symptom sore of 3.84 (95% 3.16–4.51). All symptoms and total symptom score improved post-operatively ($P < 0.0001$ for all symptoms). Figure 2 is a ladder plot of pre-operative and 12 months post-operative total symptom scores. Using paired t test, a significant difference was demonstrated between total symptom score post-operatively at 12 months in comparison to pre-operative symptom scores (Mean of differences = 18.1, SD 10.0, SE 1.1, 95% CI 15.9–20.3, one-sided and two-sided $P < 0.0001$).

Table 2 shows the results of linear regression analysis of the various symptoms with the total symptom score at 12 months post-operative as outcome.

After adjustment for the other factors, high pre-operative scores for nasal discharge and olfactory disturbance appear to be predictive of a higher total symptom score at 12 months. Nasal discharge was associated with an extra 1.3 points on the total symptom score at 12 months for every point increase in the pre-operative nasal discharge score. Smell disturbance was associated with an in extra 1.0 point on the total symptom score at 12 months for every point increase in pre-operative smell disturbance score. This indicates that patients with high nasal discharge score or olfactory disturbance pre-operatively score are more likely to have high total symptom scores at 12 months after surgery.

Table 3 shows the results of linear regression analysis of the various additional forms of surgery plotted against total symptom score at 12 months as the outcome. After adjustment for the other factors, only having had a polypectomy with ESS appears to be predictive of improvement in symptom scores, with patients having had a polypectomy having on average a 6.9 point greater improvement than those who did not.

Table 4 shows the results of linear regression analysis when various symptoms scores are plotted against Lund-Mackay scoring. This shows that only pre-operative facial pain score and olfactory disturbance correlated with Lund-Mackay score (r = 0.23 and r = 0.48 respectively). This is illustrated by the scatter graphs in Figs. 3 and 4. There was no clinical correlation between difference in total symptom score pre and post-operatively and Lund-Mackay score (r = 0.09).

Additionally, linear regression analysis of the difference in pre and post-operative olfactory disturbance plotted against Lund-Mackay score show a significant correlation (r = 0.05, $P < 0.0001$).

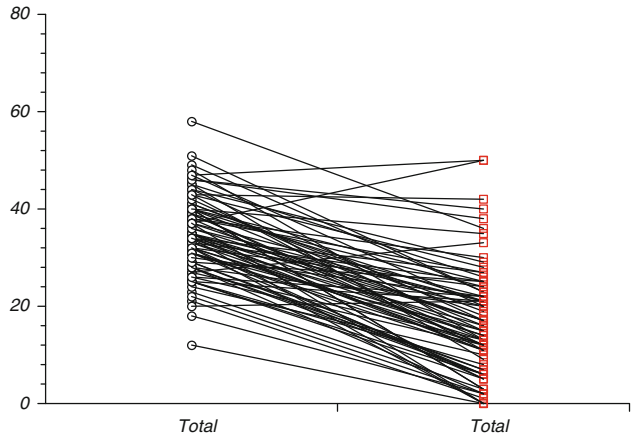

Fig. 1 Ladder plot showing total symptom score pre-operative and 12 months post-operative

Discussion

The results of this study show that patients gain benefit from endoscopic sinus surgery. This correlates with other series [3–17] and two national audits [1, 2].

The symptoms which showed the most improvement were nasal obstruction and facial pain. Whilst improvement in nasal obstruction and facial pain have been previously reported [1, 2, 12, 18–20] some studies also report in improvement in nasal discharge [21] and headache [19]. This was not the finding in this study, with high pre-operative nasal discharge score being a predictor of a higher post-operative symptom score along with olfactory disturbance. This may be because nasal discharge is associated with allergic rhinitis. Marks et al. [27] found that allergy was associated with a less favourable outcome after surgery. The incidence of allergy in both acute and chronic rhinosinusitis has been reported as 25% [28, 29]. Other studies have indicated that in atopic patients surgery alone is not enough to completely resolve episodes of sinusitis [30]. If the assumption of nasal discharge and allergy is correct, our study would support these findings. We found no correlation between pre-operative nasal discharge score and pre-operative endoscopic nasal findings or additional turbinate reduction surgery. An explanation for this maybe that previous medical therapy is masking the mucosal oedema classically associated with allergic rhinitis. Whilst it could be argued that these patients may have been better treated with medical therapies, there is evidence to show that combined surgical and medical therapy is better than medical therapy alone for the treatment of CRS [31]. Also, at present there is no good evidence to favour medical over surgical therapy alone.

Olfactory disturbance and headache symptoms scores improved the least in our study and correspond to other

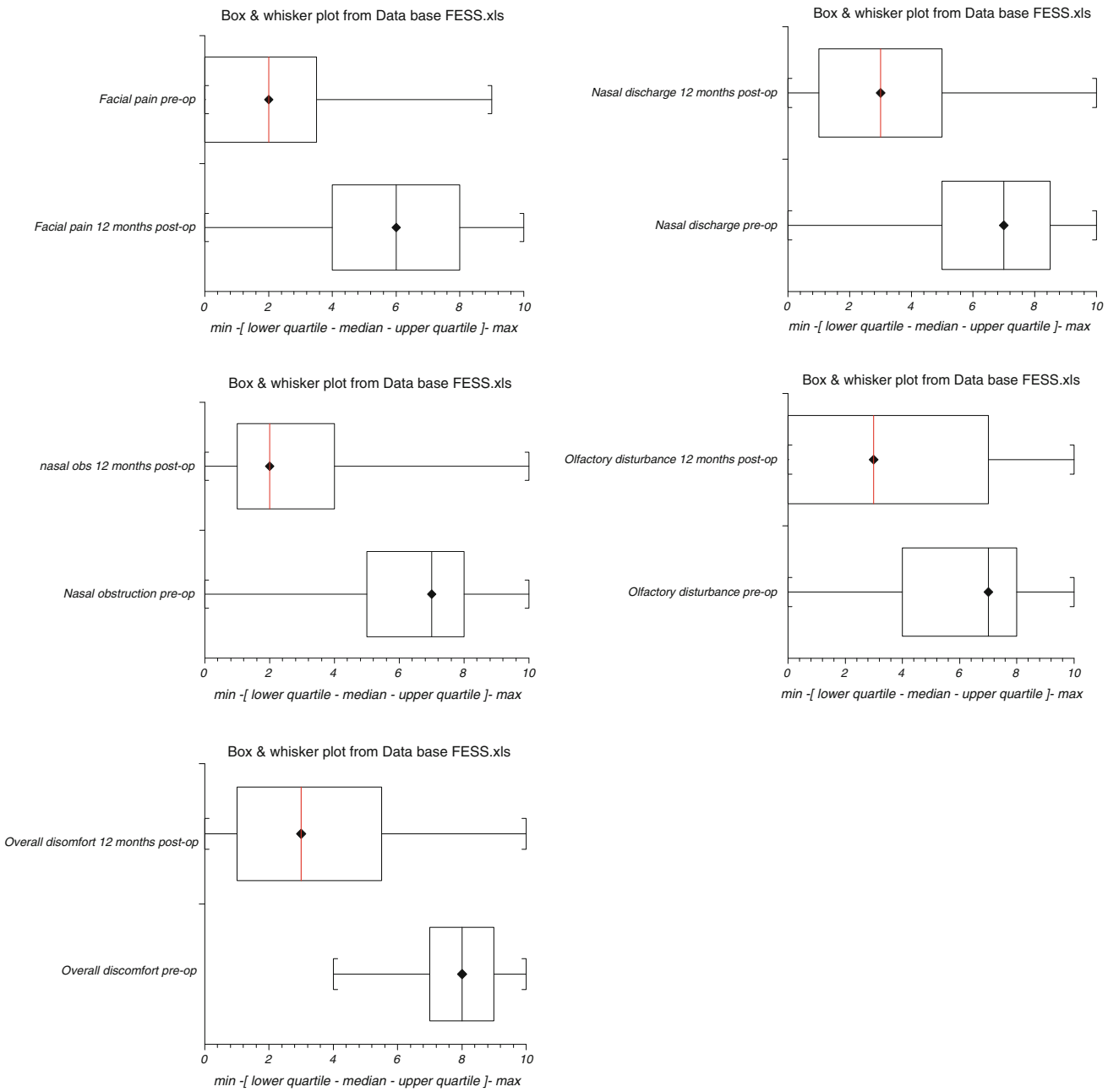

Fig. 2 Box and whisker plots for pre-operative and post operative symptom scores

published data [20]. Rowe-Jones et al. [22] examined olfaction before and after ESS objectively, and found that olfactory function is improved after ESS and was related to total nasal volume. The results from this study support this finding in that a direct correlation was demonstrated between Lund-Mackay CT score and pre-operative olfactory disturbance symptom score and symptom score improvement. This has also been tested subjectively with a greater subjective improvement in those with a high CT score [23]. This implies that patients with a high pre-operative olfactory disturbance score and high Lund-Mackay score on CT scanning have more improvement in their olfactory symptoms than those with olfactory disturbance and a low Lund-Mackay score.

Many studies have tried to establish a correlation between CT score and symptom score. We have been unable to demonstrate such a correlation, whilst other research has [3, 16, 25, 32, 33]. Sharp et al. examined the relationship between Lund-Mackay score and out come of surgery after 12 months. They found that a good surgical outcome was more likely in those patients with a score of more than 5 on the worse side. However, this relationship

Table 2 Results of linear regression with "Total score at 12 months" as outcome

Factor	Effect (95% CI)	*P* value
Sex		
Female versus male	1.8 (−3.0 to 6.6)	0.467
Age		
Per year	−0.1 (−0.3 to 0.0)	0.126
Pre-op facial pain		
Per point	0.7 (−0.4 to 1.8)	0.192
Pre-op headache		
Per point	0.6 (−0.2 to 1.4)	0.161
Pre-op nasal obstruction		
Per point	−0.1 (−1.2 to 1.1)	0.896
Pre-op nasal discharge/PND		
Per point	1.3 (0.4 to 2.1)	0.004
Pre-op smell disturbance		
Per point	1.0 (0.1 to 1.8)	0.030

Table 3 Linear regression with "Improvement in total score at 12 months" as outcome

Factor	Effect (95% CI)	*P* value
Sex		
Female versus male	0.9 (−3.5 to 5.3)	0.683
Age		
Per year	0.1 (0.0 to 0.3)	0.096
Septoplasty	4.4 (−0.4 to 9.2)	0.069
Polypectomy	6.9 (0.8 to 13.0)	0.027
SMD	3.9 (−3.9 to 11.6)	0.321

Table 4 Linear regression analysis of pre-operative symptom score against lund-mackay score

Symptom	Correlation coefficient	Two-sided *P* value
Facial pain	0.23	0.03
Headache	0.15	0.17
Nasal obstruction	0.21	0.05
Olfactory disturbance	0.48	<0.0001
Nasal discharge	0.04	0.66
Overall discomfort	0.11	0.32
Total symptom score improvement	0.09	0.37

ceased when patients were stratified according to the presence or absence of systemic disease (asthma, CF, atopy etc.). However, there are additional studies which in accordance with our study have found no correlation with CT score and symptom improvement score [15, 19, 24, 34, 35] and some in which high CT score is a predictor of high

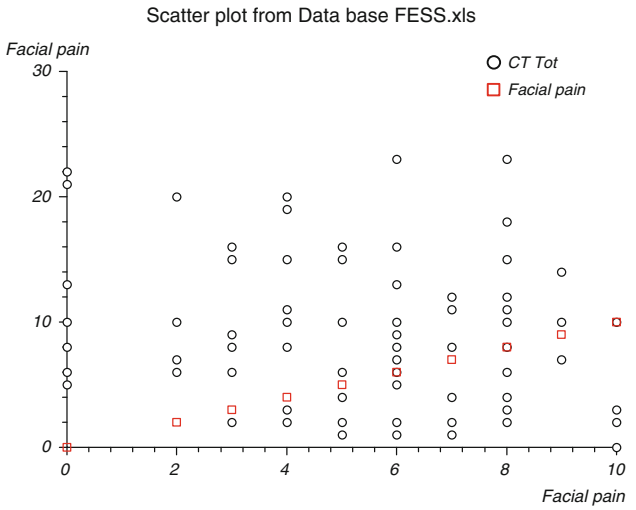

Fig. 3 Scatter graph showing the correlation between pre-operative Facial pain and Lund-Mackay score

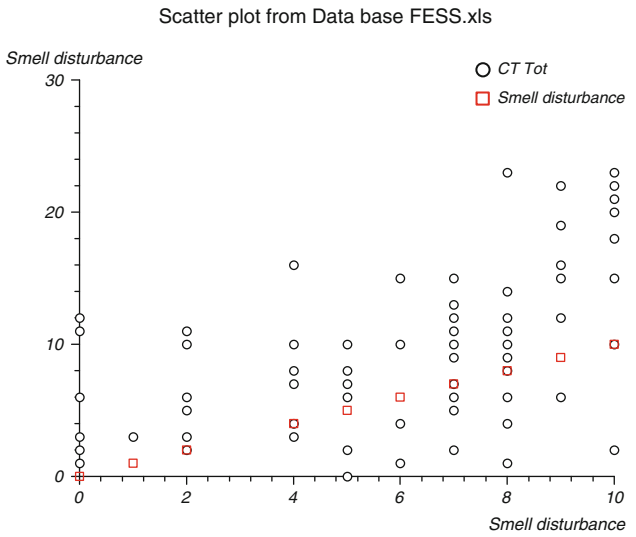

Fig. 4 Scatter graph showing correlation between olfactory disturbance and Lund-Mackay Score

post-operative symptom score [36]. This lack of correlation of CT score and symptom improvement may be of significance to those proponents of Minimally Invasive Sinus Techniques (MIST).

The presence of concha bullosa has been sited as a marker of CRS [37], whilst other studies have indicated mucosal thickening to be more indicative of CRS [38]. Fifteen patients within the study group were found to have concha bullosa, which is a small sample size to draw any conclusions from.

71 out of 81 of our patients (88%) were noted to have a deviated septum with 58 of these patients undergoing additional septoplasty. We could not demonstrate any additional improvement in post-operative symptom score

with additional septoplasty. This would appear to support those studies in which no correlation can be found between septal deviation and the prevalence of CRS [39].

A High Lund-Mackay score may be caused by nasal polyposis. Our study demonstrated that patients with polypoidal disease had greater improvement in post-operative symptoms. This also correlates with other studies including the National Comparative Audits [1, 2] but does contradict others [40]. Due to the small number of patients within the study group having CRS with polyposis, we are unable to comment on polyp size in relation to pre- and post-operative surgical symptom scores, but others have demonstrated a link between polyp size and improvement in symptom score.

The limitations of this study are that a non-validated questionnaire has been used and the short review period. However, the shorter visual analogue scale is a recognised method of symptomatology analysis [41] and appears to have yielded a high response rate. Also, Senior et al. [15] demonstrated that symptom improvement score at 1.5 years was maintained after 7.8 years. Additionally, we did not subclassify the groups e.g., asthma, atopy, as suggested by the European Position Paper on Rhinosinusitis and Nasal Polyps[40] but with this sample size it may not have been possible to obtain significant statistics. The European Position Paper on Rhinosinusitis and Nasal Polyps has suggested that future studies should 'guide clinicians to a rational use of medical and/or surgical therapies [40]. This study has given an indication as to which pre-operative symptoms may lead to a better outcome after surgery and hopefully will aid patient selection and pre-operative counselling.

Conclusion

This study demonstrates that ESS is an effective treatment for CRS, but high symptom scores for olfactory disturbance and nasal discharge may be predictors of a less favourable post-operative symptom score. Patients undergoing concurrent endoscopic polypectomy report the greatest symptomatic relief. Pre-operative Lund-Mackay score does not correlate with pre-operative or post-operative symptom score, but it does correlate with pre-operative facial pain score and olfactory disturbance score.

Acknowledgments We would like to thank Sarah Rhodes, medical statistician, for her help in preparing this paper.

References

1. Harkness P, Brown P, Fowler S, Topham J et al (1997) A national audit of sinus surgery. Results of the Royal College of Surgeons of England comparative audit of ENT surgery. Clin Otolaryngol 22:147–151
2. Hopkins C, Browne JP, Slack R, Lund V, Topham J, Reeves B, Copley L, Brown P, van der Meulen J (2006) The national comparative audit of surgery for nasal polyposis and chronic rhinosinusitis. Clin Otolaryngol 31:390–398
3. Kennedy DW, Zinreich SJ, Shaalan H, Kuhn F, Naclerio R, Loch E (1987) Endoscopic middle meatal antrostomy: theory, technique and patency. Laryngoscope 97:1–9
4. Hosemann W, Wigand ME, Fehle R, Sebastian J, Diepgen DL (1988) Results of endonasal ethmoid bone operations in diffuse hyperplastic chronic paranasal sinusitis. Hno 36:54–59
5. Rice DH (1989) Endoscopic sinus surgery: results at 2-year follow-up. Otolaryngol Head Neck Surg 101:476–479
6. Schaefer SD, Manning S, Close LG (1989) Endoscopic paranasal sinus surgery: indications and considerations. Laryngoscope 99:1–5
7. Levine HL (1990) Functional endoscopic sinus surgery: evaluation, surgery and follow-up of 250 patients. Laryngoscope 100: 79–84
8. Matthews BL, Smith LE, Jones R, Miller C, Brookschmidt JK (1991) Endoscopic sinus surgery: outcome in 155 patients. Otolaryngol Head Neck Surg 104:244–246
9. Stammberger H, Posawetz W (1990) Functional endoscopic sinus surgery. Concept, indications and results of the Messerklinger technique. Eur Arch Otorhinolaryngol 247:63–76
10. Wigand ME, Hosemann WG (1991) Results of endoscopic surgery of the paranasal sinuses and anterior skull base. J Otolaryngol 20:385–390
11. Schaitkin B, May M, Shapiro A, Fucci M, Mester SJ (1993) Endoscopic sinus surgery: 4 year follow-up on the first 100 patients. Laryngoscope 103:1117–1120
12. Lund VJ, Mackay IS (1994) Outcome assessment of endoscopic sinus surgery. J R Soc Med 87:70–72
13. Danielsen A, Olofsson J (1996) Endoscopic endonasal sinus surgery. A long term follow-up study. Acta Otolaryngol 116:611–619
14. Weber R, Draf W, Keerl R, Schick B, Saha A (1997) Endonasal microendoscopic pansinus operation in chronic sinusitis II. Results and complications. Am J Otolaryngol 18:247–253
15. Senior BA, Kennedy DW, Tanabodee J, Kroger H, Hassab M, Lanza D (1998) Long term results of functional endoscopic sinus surgery. Laryngoscope 108:151–157
16. Sobol SE, Wright ED, Frenkiel S (1998) One year outcome analysis of functional endoscopic sinus surgery for chronic sinusitis. J Otolaryngol 27:252–257
17. Jakobsen J, Svendstrup F (2000) Functional endoscopic sinus surgery in chronic sinusitis—a seriesof 237 consectively operated patients. Acta Otolaryngol Suppl 543:158–161
18. Mehanna H, Mills J, Kelly B, McGarry GW (2002) Benefit from endoscopic sinus surgery. Clin Otol 27:464–471
19. Gheriani H, Curran A, Timon C (2006) Endoscopic sinus surgery outcome in patients with symptomatic chronic rhino sinusitis and minimal changes on computerised Tomography. Irish Med J 99:15–16
20. Bhattacharya N (2004) Symptom outcomes after endoscopic sinus surgery for chronic rhinosinusitis. Arch Otolaryngol Head Neck Surg 130:329–333
21. Damm M, Quante G, Jungehuelsing M, Stennart E (2002) Impact of functional endoscopic sinus surgery on symptoms and quality of life in chronic rhinosinusitis. Laryngoscope 112:310–315
22. Rowe-Jones JM, Mackay IS (1997) A prospective study of olfaction following endoscopic sinus surgery with adjuvant medical treatment. Clin Otolaryngol 22:377–381
23. Perry BF, Kountakis SE (2003) Subjective improvement of olfactory function after endoscopic sinus surgery for chronic rhinosinusitis. Am J Otolaryngol 24:366–369
24. Holbrook EH, Brown CL, Lyden ER, Leopold DA (2005) Lack of significant correlation between rhinosinusitis symptoms and

specific regions of sinus computer tomography scans. Am J Rhinol 19(4):382–387
25. Wabnitz DAM, Nair S, Wormald PJ (2005) Correlation between pre-operative symptom scores, quality of life questionnaires, and staging with computed tomography in patients with chronic rhinosinusitis. Am J Rhinol 19(1):91–96
26. Report of Rhinosinusitis Task Force Committee Meeting (1997) Alexandria, Virginia, August 17, 1996. Otolaryngol Head Neck Surg 117(3 Part 2): S1–68
27. Marks SC, Shamsa F (1997) Evaluation of prognostic factors in endoscopic sinus surgery. Am J Rhinol 11(3):187–191
28. Savolainen S (1989) Allergy in patients with acute maxillary sinusitis. Allergy 44(2):116–122
29. Newman LJ, Platts-Mills TA, Phillips CD, Hazen KC, Gross CW (1994) Chronic sinusitis. Relationship of computed tomographic findings to allergy, asthma and eosinophilia. JAMA 271(5):363–367
30. Lane AP, Pine HS, Pillsbury HC 3rd (2001) Allergy testing and immunotherapy in an academic otolaryngology practice: a 20-year review. Otolaryngol Head Neck Surg 124(1):9–15
31. Gliklich RE, Metson R (1997) Effect of sinus surgery on quality of life. Otolaryngol Head Neck Surg 117(1):12–17
32. Smith TL, Mendolia-Loffredo S, Loehrl TA, Sparapani R, Laud PW, Nattinger AB (2005) Predictive factors and outcomes in endoscopic sinus surgery for chronic rhinosinusitis. Laryngoscope 115:2199–2205
33. Sharp HR, Rowe-Jones JM, Mackay IS (1999) The outcome of endoscopic sinus surgery: correlation with computerized tomography score and systemic disease. Clin Otolaryngol 24:39–42
34. Yeak S, Siow JK, John AB (1999) An audit of endoscopic sinus surgery. Singapore Med J 40:18–22
35. Bradley DT, Kountakis SE (2005) Correlation between computed tomography scores and symptomatic improvement after endoscopic sinus surgery. Laryngoscope 115:466–469
36. Wang P, Chu C, Liang S, Taai C (2002) Outcome predictors for endoscopic sinus surgery. Otolaryngol Head Neck Surg 126: 154–159
37. Zinreich SJ, Mattox DE, Kennedy DW, Chisholm HL, Diffley DM, Rosenbaum AE (1988) Concha Bullosa: CT evaluation. J Comput Assist Tomogr 12:4–788
38. Jones NS (2002) CT of the paranasal sinuses: a review of the correlation with clinical, surgical and histopathological findings. Clin Otolaryngol 27(1):11–17
39. Yasan H, Dogru H, Baykal B, Douner F, Tuz M (2005) What is the relationship between chronic sinus disease and isolated nasal septal deviation? Otolaryngol Head Neck Surg 133(2):190–193
40. Deal RT, Kountakis SE (2004) Significance of nasal polyps in chronic rhinosinusitis: symptoms and surgical outcomes. Laryngoscope 114:1932–1935
41. Fokkens W, Lund V, Mullol J (2007) European position paper on rhinosinusitis and nasal polyps 2007. Rhinology 20: 1–136