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RHINITIS, CONJUNCTIVITIS, AND SINUSITIS (J OPPENHEIMER AND J CORREN, SECTION EDITORS)

Effect of Functional Endoscopic Sinus Surgery on Outcomes in Chronic Rhinosinusitis

Mikkel Christian Alanin[1] · Claire Hopkins[1]

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Abstract

Purpose of Review Chronic rhinosinusitis (CRS) has a significant negative impact on quality of life (QoL). Surgical treatment of CRS is indicated when medical therapy fails to achieve adequate symptom control. This review summarizes the latest information on the outcomes after endoscopic sinus surgery (ESS) with relation to QoL, revision rates, olfaction, absenteeism, asthma control, use of systemic medications, quality of sleep and complications. We also provide an update regarding the factors that can impact outcomes.

Recent Findings CRS has classically been divided into two phenotypes depending on the presence or absence of nasal polyps. However, this is an oversimplification as many factors impact disease burden and outcome after treatment. It has been demonstrated that in many cases, ESS fails to meet the expectations of the patients. Evidence based patient counselling is key to help surgeons guide their patients in the best possible way to make well-informed decisions.

Summary Repeatedly it has been demonstrated that ESS improves QoL, improves olfaction, leads to better asthma control and less use of systemic antibiotics. However, various patient characteristics including phenotype, disease burden, comorbidities, age, gender and surgical technique can influence the outcome after ESSIt is of paramount importance to include a follow-up period when discussing revision rates. Based on available data, the genuine revision rate is probably 15–20% after five to ten years of follow-up. The revision rate is also affected by various factors and comorbidities.

Keywords Sinus surgery · Outcomes · PROMS · Revision rates

Introduction

Chronic rhinosinusitis (CRS) affects approximately 11% of the adult population [1]. It has classically been divided into two phenotypes depending on the presence or absence of nasal polyps. The majority of patients has CRS without nasal polyps (CRSsNP),whereas the subgroup with polyps (CRSwNP) has an estimated prevalence of 2–4% [2]. However, this is an over simplification as many factors impact disease burden and outcome after treatment. In the new EPOS2020 [3••], primary CRS is classified according to the endotype dominance into "type 2" and "non-type 2". The majority of CRSwNP is type 2, and conversely the majority of CRSsNP is non-type 2, but endotype and phenotype are not perfectly aligned; for example, 15% of CRSwNP may be non-type 2 in western populations.

Cardinal symptoms of CRS include nasal congestion, decreased or absent sense of smell, anterior or posterior nasal discharge, facial pain or pressure and sleep disturbance [3••]. It has repeatedly been demonstrated that CRS significantly and negatively impacts on the quality of life (QoL).

The primary aims of CRS treatment are to reduce symptoms and improve QoL. Treatment is primarily medical with only few exceptions such as allergic fungal rhinosinusitis, fungal ball or when there is a suspicion of malignancy. Otherwise, surgery should be reserved for patients who fail to achieve satisfactory symptom control with appropriate medical therapy.

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✉ Mikkel Christian Alanin
mikkel.alanin@gstt.nhs.uk

[1] Guy's Hospital, Great Maze Pond, London SE1 9RT, UK

Nevertheless, surgical treatment of CRS is frequent. In the USA, over 250,000 sinus surgeries are performed annually [4].

Smith and colleagues [5] reported that only 60% of patients who underwent endoscopic sinus surgery (ESS) found that their postoperative improvement in symptoms matched their expectations. In addition, there is only limited evidence for the long-term effects of ESS [5,6•]. In this paper, we aim to review the effect of ESS on outcomes such as QoL, revision rates, asthma, quality of sleep, olfaction, complications, the use of systemic therapies and absenteeism. In addition, we will highlight factors that may affect it. This information is key to help ENT surgeons guide their patients in the best possible way to make well-informed decisions. This is of paramount importance in a time of targeted medicine and where new treatment options are rapidly emerging such as biologicals, balloon sinuplasty and drug-eluting stents.

Quality of Life

Patient-recorded outcome measures (PROMS) focus on the patients´ perspective. Importantly, CRS-specific QoL has been presented to be the leading cause for CRS patients to seek medical attention [7]. CRS significantly impairs QoL and has been reported to have a greater impact on social function and pain compared with other chronic conditions such as angina, chronic obstructive pulmonary disease and chronic back pain [8].

A variety of validated questionnaires have been used in CRS research and clinical settings; however, the most commonly used sinus precise quality of life tool is the 22-item Sinonasal Outcome Test (SNOT-22). The minimum change in the SNOT-22 score that can be detected by a patient is reported to be 8.9 points [9], which is also known as the minimally clinically important difference (MCID).

Repetitively it has been reported that ESS significantly improves QoL: In the UK audit, which included 3128 patients who underwent surgery for all CRS phenotypes, the mean SNOT-22 score was found to improve from 40.9 to 28.2 postoperatively, and the effect was maintained throughout the 5-year follow-up period [10•]. In addition, a recent systematic review by Soler et al. including 40 unique cohorts and a total of 5547 CRS patients having surgery between 2008 and 2016 established that the MCID was achieved in all studies. The mean improvement was 24.4 (range 12.7–44.8) after a mean follow-up of 10.6 months.

Phenotype

How phenotype affects improvement in QoL after ESS has been debated. Some have shown a greater mean improvement following ESS with the CRSwNP subtype [10•,11], whereas Smith et al. found that patients with CRSsNP experienced the largest improvements in PROMs [5].

Preoperative Burden: Symptoms, Radiology and Polyp Score

Characteristically, the patient's preoperative symptom burden is related to outcome. Several studies have demonstrated an association between high preoperative SNOT-22 score and greater improvement [7, 12, 13]. This was also demonstrated by Hopkins et al. in a prospective cohort study of 2263 patients, where the chance of achieving a MCID was dependant on baseline SNOT-22 score. In patients with a baseline SNOT-22 score of more than 20, greater than 50% achieved the MCID, while patients with a score above 30 had a greater than 70% chance of achieving the MCID [13]. Intuitively, extra careful consideration and discussion with the patient should be taken before offering ESS in a patient with a low SNOT-22 score. A systematic review and meta-analysis reported no correlation with neither polyp score or CT score and SNOT 22 outcome [14]. Similarly, a recent retrospective study found no correlation between preoperative radiographic sinus disease, extent of surgery and QoL outcome [15].

Comorbidities

CRS is associated with psychiatric disorders such as depression and anxiety. In a comprehensive meta-analysis by Loftus et al. including 34,220 CRS patients, there was no significant difference in improvements in QoL after surgery in patients with or without depression [6•]. Interestingly, although patients with depression usually report higher symptom burden pre- and postoperatively, they experience the same level of change. Furthermore, ESS has been shown to improve depression. In a study by Schloser et al. [16], a 50% reduction in the Patient Health Questionnaire (PHQ2) was seen after surgery, and 65% of patients with depression at baseline was categorized as not having depression after ESS. It should be noted that similar results were achieved with medical therapy alone.Comorbid anxiety is associated with higher baseline symptom burden in the psychological subdomain of the SNOT-22 and related to less effect on olfactory function following ESS [17]. Comorbid asthma has been reported to positively affect QoL outcome after ESS. In a retrospective analysis including 376 patients, Zhang et al. [18] found that the combination of CRSwNP and asthma was associated with a greater improvement in SNOT-22 compared with CRS patients without asthma. Similarly, Soler et al. reported in a systematic review that the prevalence of asthma was associated with greater improvement in QoL after ESS [14]. It is likely in part to be related to higher preoperative symptom and disease severity, and the benefits may not be well maintained in long term (see revision rates).

Non-steroidal anti-inflammatory drug (NSAID)-exacerbated respiratory disease (N-ERD) is defined as the combination of eosinophilic asthma, nasal polyps and adverse respiratory reactions to NSAIDs that inhibit the cyclooxygenase-1 (COX-1) enzyme. Patients with N-ERD have been reported to have more difficult to treat symptoms and significantly lower QoL than other CRSwNP patients [19]. An observational cohort study, using EPOS criteria for disease control, discovered that N-ERD was significantly associated with higher prevalence of uncontrolled disease compared with other CRSwNP patients 3 to 5 years after surgery [20]. A recent qualitative study also highlighted that many N-ERD patients are living with uncontrolled disease and are frustrated by the ineffectiveness of standard treatment options and the lack of awareness of N-ERD in the medical community [21]. This may be a critical group in relation to the emerging treatment options such as drug-eluting stents and biological treatments.

Allergic fungal rhinosinusitis (AFRS) is a non-invasive fungal infection with fungal hyphae in the sinuses, antifungal IgE sensitivity, eosinophilic mucus and nasal polyps. These patients often require combined ESS and comprehensive postoperative medical therapy to keep the disease under control [22].

Smoking

Smoking is a risk factor for developing CRS [1]; however, studies examining the effect of smoking on QoL after ESS have not found any association [23–25].

Timing

The importance of timely surgical intervention is questioned. Some reports favour timely intervention showing a greater improvement in the SNOT-22 and with less postoperative healthcare needs [26, 27], while others have demonstrated that patients with long-term symptom duration had the greatest postoperative QoL improvement [28], and still another study with a waiting time of 32 weeks before surgery found no association [12]. Nevertheless, prolonged waiting for surgery may lead to more absence from work.

Gender

Lal et al. report in a retrospective analysis including 248 patients no difference between genders in relation to outcome 1 year after ESS. However, females reported higher disease burden in the preoperative segment [29]. Van der Veen et al. reported that female gender was associated with a higher prevalence of uncontrolled disease 3 to 5 years after ESS [20].

Olfaction

Decreased or absent sense of smell is a hallmark of CRS that often improve after ESS. Interestingly, olfactory dysfunction before ESS has been associated with better QoL outcomes [11]. A meta-analysis of 31 studies assessing olfactory outcomes in patients with CRS subsequent ESS showed that the vast majority of both subjective and objective measures of olfactory function improved [30]. Improvement of olfaction-specific QoL was also established in a multi-centre prospective study [31]. Not surprisingly, preoperative lesions in the olfactory cleft have been negatively related to olfactory outcomes [32]. With respect to olfactory outcomes, Bogdanov et al. [33] demonstrated that for patients with olfactory loss, the response in olfactory function to oral corticosteroids (OCS) predicted the outcome of surgery; improvements after OCS and surgery were significantly correlated; and no patient responded to surgery who did not respond to OCS. This would be a useful test to avoid patient dissatisfaction after surgery if hyposmia was their main driver to seek intervention.

Among all CRS patients, it has been shown that more than 65% will realize a clinically meaningful improvement in QoL after ESS [13] and that primary ESS patients are twice as likely to improve as patients undergoing revision [24].

Revision Rates

Revision rates after ESS have to be stated for a specific time point, and studies with a short follow-up period may underestimate the genuine revision rate. In a recent meta-analysis by Loftus et al., including 34,220 CRS patients, a linear relationship between follow-up time and revision was demonstrated. The mean follow-up was 7.4 years, and the overall revision rate was 18.6% [6•]. Similar findings were recently reported by Smith et al. [34]. In their analysis, including 29,934 patients from the Utah database using electronic health records, the overall revision rate was 15.9% after 9.7 years (mean). Finally, among the 1459 patients in the English national comparative study [10•], the revision rate at 5-year follow-up was 19.1%.

Phenotype

The phenotype affects the revision rate. Persistently it has been shown that CRSwNP patients are more likely to require revision surgery than patients without polyps.

Hopkins et al. reported in the English national comparative study that among the 1459 patients who completed the 5-year follow-up, the revision rate for CRSwNP was 21% compared with 16% for patients with CRSsNP [10•]. In the Utah database, the long-term revision rate was reported at 30% for CRSwNP versus 16% for CRSsNP, with CRSwNP patients also being more prone to require multiple revision procedures. When examining factors associated with increased risk of revision, the presence of polyps had the largest impact [34].

Comparably, a recent retrospective study including 338 CRSwNP patients found a revision rate of 24.9% after 52.6 months of follow-up [23].

Analogously, Smith et al. also found that CRSwNP patients were more likely to require revision surgery with a revision rate of 25% after 10 years of follow-up, and half of those patients had comorbid N-ERD [5].

Comorbidities

As much as 40% of patients with CRSwNP are thought to have N-ERD [6•], this group of patients are also habitually reported to have higher rates of revision surgery compared with other CRSwNP patients. Loftus et al. included 465 patients with N-ERD in their analysis and found that 27.2% required revision surgery after a mean follow-up of 36.5 months [6•].

Asthma without intolerance to NSAIDs has also been reported as an important risk factor for revision surgery [34]. Loftus and colleagues reported a 22.6% risk of revision in patients with CRSwNP compared with 8% for CRSwNP patients without comorbid asthma after 7.4 years. The difference was statistically significant [6•].

Patients with AFRS also often have more recalcitrant disease. Loftus et al. reported that among the 467 patients with AFRS from 15 studies included in the meta-analysis, 28.7% required revision surgery after a mean follow-up of 27.9 months (however, not all included studies had extractable revision times) [6•].

Gender

In the Utah database study including 29,934 patients, female gender was associated with an increased risk of revision surgery [34], which also has been demonstrated by Stein et al. in a retrospective cohort of 61,339 patients [35].

Surgical Approach

In CRSwNP patients, surgical techniques have been associated with polyp recurrence or revisions rate. Alsharif et al. described the “reboot technique” with removing all of the diseased mucosa from the paranasal sinuses and found a reduced recurrence of polyps compared with a mucosa sparing approach [36]. Using the Draf III procedure, with the creation of maximum access to the frontal sinus, has also been shown to significantly lower the risk of revision [37].

Asthma Control

CRS and asthma often co-exist. It has been disputed if ESS can improve asthma. A systematic review on asthma outcomes following ESS included 22 studies and 891 patients. They found that 76% of patients reported improved asthma control, 85% experienced fewer asthma attacks, and 64% had decreased hospitalizations. However, the study failed to show a significant improvement in lung function [38]. Another recent review demonstrated a weak association between ESS and improvements in pulmonary function tests but stated that it was established on low-quality evidence [39]. Schlosser et al. [40] demonstrated in a prospective study including 86 patients with CRS and comorbid asthma using validated asthma-specific outcomes measures that asthma-specific QoL improved and the prevalence of self-evaluated uncontrolled asthma decreased from 51 to 32% after ESS.

It has been proposed that patients with long-term CRS prior to ESS have increased risk of developing asthma and that the risk returns to baseline after ESS. Benninger et al. [41] demonstrated that medically recalcitrant CRS was associated with a 5% annual rate of new onset asthma, but it levelled out to 1% per year after ESS. Likewise, Smith et al. [5] demonstrated a risk of less than 1% for new onset asthma after ESS. These studies highlight the importance of considering timely intervention.

Absenteeism and Productivity

CRS is associated with high rates of absenteeism, reduced productivity (presenteeism), and lost leisure time due to the disease [42], which has a substantial economic burden [43]. ESS has been shown to reduce absenteeism from work [44] and increase performance while working. In a prospective, multi-institutional study by Rudmik et al. [45] including 27 patients with a mean follow-up of 15 months, the absenteeism and presenteeism were significantly reduced from 63 days to 22 days postoperatively.

Impairments in sleep due to CRS have also been related to the productivity loss [46].

Sleep Quality

Poor quality of sleep is a cardinal symptom of CRS, and ESS has been shown to improve sleep quality as measured by the Pittsburgh Sleep Quality Index [47], the Epworth Sleepiness Scale [48], and in the sleep domain of the SNOT-22 [49].

Use of Systemic Therapies

Repeated antibiotic treatment is often administered in refractory CRS although its role is controversial. Nevertheless, a report shows that it is prescribed in nearly 70% of all CRS outpatient visits [50]. Repeated courses of systemic antibiotics may be used in uncontrolled disease before escalating to surgical intervention. A recent prospective study found no correlation between high utilization of antibiotics prior to surgery and outcome [51].However, ESS can reduce the need for both systemic antibiotic and OCS. In a prospective multi-institutional cohort including 75 patients, a significant decrease in both antibiotic and steroid use was proven after ESS [52]. In a register study with 8963 patients, Purcel et al. [53] demonstrated a significant decrease in the use of antibiotics, whereas they found no change in use of systemic steroids after surgery.

Complications

The incidence of major complications after ESS is reported to be between 0.36 and 1% [54, 55]. Major complications include cerebrospinal fluid (CSF) leak, haemorrhage requiring transfusion or return to theatre, and orbital injuries.Revision surgery is often reported more likely to cause major complications due to altered anatomy and mucosal scarring. However, a study database study including 78,944 ESS cases found no statistical difference between primary and revision cases. Yet, the use of image guidance, a more comprehensive surgery and patient age above 65 years were associated with an increased risk of a major complication [54]. However, the impact of image guidance on the risk of complications is difficult to assess in observational studies and historical studies, where IGS is not used in all cases and thus has considerable selection bias.

Conclusion

Various patient characteristics including phenotype, disease burden, comorbidities, age, gender and surgical technique can influence on the outcome after ESS. Some of the studies included in this paper report conflicting results; however, some trends exist. As our understanding of CRS pathophysiology expands, further stratification of CRS into additional subgroups is likely to occur that will allow us to provide more personalized guidance to patients regarding their outcome after surgery.

Repeatedly it has been demonstrated that ESS improves QoL, and a high symptom burden as measured by the SNOT 22 preoperatively is associated with a larger improvement in PROMs. Female gender, depression and anxiety are often associated with a higher disease burden but does not impact the outcome with relation to CRS symptoms. In addition, there is no clear relation between preoperative CT score or polyp grade and outcome. While there are conflicting results regarding the effect of phenotype on QoL improvement, the presence of N-ERD and allergic fungal disease is associated with uncontrolled disease after surgery.

ESS can improve olfactory function, but it is evident that this most likely occurs in patients who have experienced improvement in olfaction after OCS, which may be a good screening test if anosmia is the main indication for the patient to undergo ESS.

It is of paramount importance to include a follow-up period when discussing revision rates. To date, the overall most accurate revision rate to quote to patients is probably 15–20% after 5 to 10 years. The revision rate is affected by various factors and comorbidities. The CRSwNP phenotype, the presence of polyps, asthma, N-ERD, FARS, surgical approach and female gender are the most evident risk factors for revision surgery.It is postulated that uncontrolled CRS may be a risk factor for developing asthma. It seems that ESS can improve asthma symptoms and reduce the risk of new onset asthma. ESS may lead to a reduced need of systemic courses of antibiotics and/or OCS. In addition, surgery can decrease absenteeism and increase productivity which has substantial socioeconomic implications. However, the importance of timely surgical intervention is still unsettled.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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