Laryngoscope Investigative Otolaryngology

General Health, Vitality, and Social Function After Sinus Surgery in Chronic Rhinosinusitis

Ann Helen Nilsen, RN, MSc; Anne-Sofie Helvik, RN, PhD; Wenche Moe Thorstensen, MD, PhD; Øyvind Salvesen, PhD; Vegard Bugten, MD, PhD

Objectives: Chronic rhinosinusitis (CRS) has an impact on health-related quality of life (HRQOL). The objective of this study was to examine generic and disease-specific HRQOL and symptoms in CRS patients with (CRSwNP) and without (CRSsNP) nasal polyps before and 6 months after sinus surgery, and to identify preoperative patient factors associated with HRQOL outcome in the two groups separately.

Methods: This prospective, observational study consisted of 220 CRSwNP and 196 CRSsNP patients. Generic and disease-specific HRQOL were measured using the Short-Form-Health-Survey (SF-36) and Sino-Nasal-Outcome-Test (SNOT-20). Symptoms were assessed on a visual analog scale.

Results: Preoperatively, CRSwNP patients reported worse score in general health (SF-36), rhinologic subset (SNOT-20): nasal obstruction, nasal discharge, and altered sense of smell compared to CRSsNP patients, who reported worse score in physical role, bodily pain, ear/face subset, and facial pain. After surgery, generic and disease-specific HRQOL and symptoms improved in both groups. CRSwNP patients had greater improvement in general health, vitality and social function, nasal obstruction, and altered sense of smell, compared to CRSsNP-patients. In both groups, higher age, daily smoking, and having had sinus surgery previously were associated with less generic HRQOL improvement, in addition to female sex and allergy in CRSsNP patients.

Conclusion: The greater improvement in general health, vitality, and social function after surgery may indicate a greater potential for generic HRQOL improvement in CRSwNP patients compared to CRSsNP patients. Female sex and allergy was associated with less improvement of generic HRQOL in the CRSsNP group, but not in the CRSwNP group.

Level of evidence: 2c outcome research.

Key Words: Health-related quality of life, outcome, sinusitis, surgery.

INTRODUCTION

Chronic rhinosinusitis (CRS) is characterized by mucosal inflammation of the nose and sinuses, and has an impact on patients' quality of life.[1] Both in Europe and in the United States, CRS affects 5%–15% of the general population.[2,3] CRS can be classified broadly into two groups: CRS with and without nasal polyps (CRSwNP, CRSsNP). Often, there is overlap within a broad spectrum of inflammatory disease.[1]

Several prospective studies have validated the utility of functional endoscopic sinus surgery (FESS) as treatment for CRS after failed medical treatment, and has demonstrated significant improvement in the symptoms and health-related quality of life (HRQOL) of patients.[4–7] Studies have shown that symptom severity differs in those with CRSwNP and CRSsNP, suggesting that these subgroups require thorough preoperative assessment.[8]

Patient-reported outcome measures are used to assess the impact of sinus surgery on symptoms and HRQOL,[9] and to inform and "tailor" the correct intervention to the appropriate patient.[10] The Sino-Nasal-Outcome-Test (SNOT)-20 is used frequently to assess disease-specific HRQOL,[11,12] whereas the Short-Form-Health-Survey (SF-36) is used to assess the generic HRQOL.[13]

Several studies have explored the patient characteristics associated with surgical outcomes for patients undergoing FESS,[6,14–16] but conflicting information regarding which of these characteristics are important has emerged.[15] Katotomichelakis and colleagues found that preoperative olfactory dysfunction and nasal polyps were associated with greater improvement of HRQOL,[15] whereas other studies have found worse HRQOL outcome in association with depression.[17]

Few studies have focused on and explored factors associated with the disease-specific and generic HRQOL of CRS patients with and without nasal polyps.[18]

From the Department of Otolaryngology - Head and Neck Surgery (A.H.N., A.-S.H., W.M.T., V.B.), St Olav's University hospital of Trondheim, Trondheim, Norway; Department of Neuromedicine and Movement Science (A.H.N., W.M.T., V.B.), Norwegian University of Science and Technology, Trondheim, Norway; Department of Public Health and Nursing (A.-S.H., Ø.S.), Norwegian University of Science and Technology, Trondheim, Norway

Funding: The Liaison Committee between St Olav's University hospital and the Faculty of Medicine and Health, NTNU was the main founder of this study.

Conflict of interest: The authors declare no conflict of interest.

Send correspondence to Ann Helen Nilsen, RN, MSc, Department of Otolaryngology-Head and Neck Surgery, St Olav's hospital and Department of Neuromedicine and Movement Science, Norwegian University of Science and Technology, 7006 Trondheim, Norway. Email: ann.helen.nilsen@stolav.no

DOI: 10.1002/lio2.299

We measured the HRQOL and symptoms of CRSwNP and CRSsNP patients before and after surgery. In addition, we identified preoperative patient factors associated with HRQOL outcome after surgery in the two groups separately.

MATERIALS AND METHODS

Ethical Approval of the Study Protocol

The study protocol was approved by the Committee for Medical Research Ethics in Norway (2015-367). All patients provided written informed consent before study inclusion.

Diagnosis

After evaluation of patient's symptoms, endoscopic evaluation, and CT scanning of the sinuses, the patients were planned for surgery. All patients had the same medical protocol of antibiotics combined with corticosteroids for 10 to 14 days, followed by topical corticosteroids for at least 12 weeks before they underwent FESS.

If not possible preoperatively, final differentiation of patients (CRSwNP, CRSsNP) was done by the surgeon during surgery, where the presence of polyps in the middle meatus, sinuses, or nasal cavity qualified as CRSwNP.

Inclusion Criteria

Inclusion criteria include patients with a diagnosis of CRS as defined by EPOS criteria[19] referred to sinus surgery.

Exclusion Criteria

Exclusion criteria were: age < 18 years; difficulty in interpreting questionnaires due to language/cognitive problems; pregnancy; previous/ongoing cancer treatment; granulomatosis with polyangiitis, sarcoidosis, cystic fibrosis, Kartagener syndrome, ciliary dyskinesia.

Participants

Patients were examined at the ENT Department at the outpatient clinics within St Olav's University hospital (Trondheim, Norway) from January 2012 to October 2017.

Originally, the study population consisted of 469 patients. Due to dropouts before surgery (3), loss to follow-up (27), missing pre- or postoperative data (9), and exclusion because of comorbidity (14), the total sample was 416 patients: 220 CRSwNP and 196 CRSsNP patients.

Patient-Reported Outcome Measures

GENERIC HRQOL. The generic HRQOL was assessed using SF-36v2.[20,21] It contains 36 questions belonging to eight domains: physical functioning; physical role; bodily pain; general health; vitality; social function; emotional role; and mental health. Data were scored according to the *SF-36 Analysis and Interpretation Manual*.[22] A change of 0.5 SD is considered clinically significant.[23]

DISEASE-SPECIFIC HRQOL. Disease-specific HRQOL was assessed using SNOT-20.[11] The twenty items scale had response options from 0 ("no problem") to 5 ("problem as severe as can be"). SNOT-20 is divided into four subsets[24] related to nose issues, ear and face issues, sleep function, and psychological issues. A mean score was calculated for each subset and all items (total score). A change of 0.8 points is considered clinically significant.[11]

SYMPTOMS. Patient-reported symptoms were nasal obstruction, facial pain and sinus pressure, altered sense of smell, and nasal discharge. Symptoms were indicated on a 100-mm visual analog scale (VAS) in which 0 mm represented "no symptoms" and 100 mm represented "symptoms as troublesome as possible".[25] A change of 0.5 SD was considered clinically significant.[23]

Surgical Procedures and Postoperative Care

The extent of surgery varied due to the extent of disease and could include uncinectomy and antrostomy to maxillary sinus, anterior ethmoidectomy, posterior ethmoidectomy, sphenoidectomy, and opening of the drainage pathway from frontal sinus. Polyps were removed with shaver.

Balloon sinuplasty was not utilized. If indicated, inferior turbinate reduction and/or septoplasty were done to further maximize nasal patency.

Surgical procedures were carried out by 15 surgeons (seven consultants and eight senior registrars) at St Olav's University hospital. The surgeons with more experience did the more advanced procedures.

Postoperatively, most patients had a packing in middle meatus for 4–7 days to prevent adhesions.[26] The surgeons performed debridement under endoscopic visualization 12–14 days postoperatively to remove crusts and secretions from the nasal cavity[27] and to open the nose for treatment with local steroids.[28] If necessary, additional debridement were planned after that. The patients were instructed to rinse their nose with saline 4–5 times daily for 2–4 weeks postoperatively, and use topical corticosteroid spray the first year after surgery. Patients with nasal polyps were also instructed to use fluticasone nasal drops in the evening the first 4–12 weeks after surgery.

Statistical Analyses

We used PASW Statistics v23 (IBM, Armonk, NY, USA) for statistical analyses. CRSwNP and CRSsNP groups were assessed separately. Baseline characteristics between the two groups were compared using the independent-sample *t*-test and chi-square test, as appropriate. Based on the sample size and distribution of continuous data, statistical methods were used to analyze data describing symptoms and HRQOL at baseline and follow-up. For unadjusted comparison of outcomes for the two groups, unpaired and paired *t*-tests with corresponding confidence intervals were used, as appropriate.

Linear regression analysis was undertaken to investigate variables associated with the improvement in SF-36 domain scores and SNOT-20 scores 6 months after surgery. Univariable analysis were used to identify variables associated significantly ($P \leq .05$) with improvement of each HRQOL outcome, and these variables, age, sex, smoking, allergy, asthma, previous surgery, and the preoperative value of the dependent variable, were then included in the multivariable analysis to examine for further associations in the CRSwNP and CRSsNP group separately.

Power calculations showed that a difference in SNOT-20 of 0.6 (SD 1.2) between the groups and with 80% power and 5% significance required 40 patients with CRSwNP and CRSsNP.

RESULTS

The baseline characteristics of the two CRS subgroups undergoing FESS differed in demographic and medical characteristics in age, sex, ASA intolerance, asthma, and previous FESS surgery (Table I).

TABLE I.
Demographic and Medical Characteristics.

	CRSwNP $N = 220$	CRSsNP $N = 196$	Total $N = 416$	P
Sex (M/F)	147/73	74/122	221/195	.001
Mean age, years (range)	49.1 (18–84)	42.2 (18–80)	45.8 (18–84)	.001
Mean BMI, kg/m^2 (range)	26.9 (17.3–48.3)	26.2 (16.9–47.8)	26.6 (16.9–48.3)	.153
Daily smokers, *n* (%)	18 (8.3)	25 (12.8)	43 (10.4)	.134
Allergy, *n* (%)	107 (50.7)	80 (41.9)	137 (46.5)	.076
ASA intolerance *n*, (%)	27 (13.0)	3 (1.6)	30 (7.6)	.001
Asthma, *n* (%)	97 (45.3)	33 (17.6)	130 (32.3)	.001
Previous sinus surgery, *n* (%)	118 (53.6)	67 (34.2)	185 (44.5)	.001

Differences between groups are presented with *P*-values.
ASA = acetylsalicylic acid.

Generic HRQOL

Preoperatively, CRSwNP patients reported significantly ($P \leq .001$) better scores in the domains of physical role and bodily pain compared with CRSsNP patients (Table II). After surgery, both groups reported significant ($P = .001$) improvement in all eight domains, except for general health in the CRSsNP group (Fig. 1). A clinically significant improvement was found in both groups with regard to vitality, social function, and mental health, in addition to general health in the CRSwNP group, and physical role and bodily pain in the CRSsNP group. CRSwNP patients had significantly greater improvement in general health, vitality, and social function compared with CRSsNP patients ($P \leq .018$). Postoperatively, CRSwNP patients continued to have significantly better scores in physical role and bodily pain ($P \leq .025$), as well as better scores in vitality and social function ($P \leq .007$), compared with CRSsNP patients.

Disease-Specific HRQOL

Preoperatively, the total SNOT-20 score showed no significant differences between the two patient groups (Table III). When analyzing the subsets, CRSwNP patients had a significantly worse score in the rhinologic subset compared with CRSsNP patients ($P = .001$), whereas CRSsNP patients had a significantly worse score ear/facial subset score compared with CRSwNP patients ($P = .034$). Six months after surgery, the SNOT-20 score and all subset

TABLE II.
Generic HRQOL Before and 6 Months After Surgery.

	CRSwNP Pre $n = 220$	CRSwNP Post $n = 220$	Improvement	CRSsNP Pre $n = 196$	CRSsNP Post $n = 196$	Improvement	Difference Pre-value	Difference Post-value	Difference Improvement
Physical functioning	80.0	85.8	5.93**	78.5	86.7	8.23**	1.76	0.70	2.30
	[77.4–82.6]	[83.4–88.3]	[3.49–8.37]	[75.6–80.9]	[84.2–88.8]	[6.02–10.4]	[−2.00 to 5.50]	[2.70–4.10]	[1.02–5.62]
Role physical	60.6	71.4	10.3**	51.0	66.3	15.4**	9.42**	5.13*	5.02
	[57.2–64.1]	[68.1–74.6]	[7.09–13.6]	[47.3–55.1]	[62.7–69.8]	[11.4–19.3]	[4.27–14.6]	[0.36–9.89]	[0.05–10.1]
Bodily pain	60.5	70.4	9.67**	47.5	61.4	13.9**	12.8**	8.31*	4.24
	[57.0–64.0]	[66.8–73.9]	[6.33–13.0]	[44.3–51.1]	[58.3–65.8]	[9.90–17.9]	[7.94–17.7]	[3.12–13.5]	[−0.92 to 9.40]
General health	55.4	62.6	7.09**	57.9	58.5	0.63	2.52*	4.01	6.46*
	[53.9–56.8]	[59.3–65.8]	[3.28–10.9]	[56.2–59.6]	[55.0–62.1]	[−3.66 to 4.93]	[0.29–4.75]	[−0.76 to 8.77]	[0.76–12.2]
Vitality	43.0	56.3	13.3**	42.5	48.9	6.41**	0.51	6.92**	6.99**
	[41.9–44.1]	[53.8–58.8]	[10.5–16.1]	[41.1–43.8]	[46.7–52.1]	[3.17–9.49]	[−1.19 to 2.21]	[3.23–10.6]	[2.81–11.2]
Social function	50.3	85.1	34.8**	50.5	79.8	29.4**	0.11	5.19*	5.41*
	[49.2–51.3]	[82.2–88.0]	[31.7–37.8]	[49.0–51.8]	[76.5–83.3]	[25.6–33.1]	[−1.66 to 1.87]	[0.71–9.66]	[0.59–10.21]
Role emotional	81.6	90.3	8.45**	79.7	87.4	7.76**	1.77	2.58	0.69
	[78.3–85.0]	[87.7–92.8]	[5.25–11.7]	[76.2–83.6]	[84.7–90.6]	[3.97–11.6]	[−3.18 to 6.71]	[−1.29 to 6.46]	[−4.23 to 5.60]
Mental health	55.5	72.5	16.9**	55.1	70.0	14.9**	0.49	2.23	2.01
	[54.5–56.5]	[70.8–74.1]	[15.1–18.8]	[54.0–56.1]	[68.4–72.1]	[13.0–16.9]	[−0.93 to 1.91]	[−0.27 to 4.73]	[−0.712 to 4.72]

Data are the mean with confidence intervals (CIs) of SF-36.
*$P < .05$.
**$P < 0.01$.
CRS = chronic rhinosinusitis; Difference = difference between CRS groups; Post = postoperatively; Pre = preoperatively.

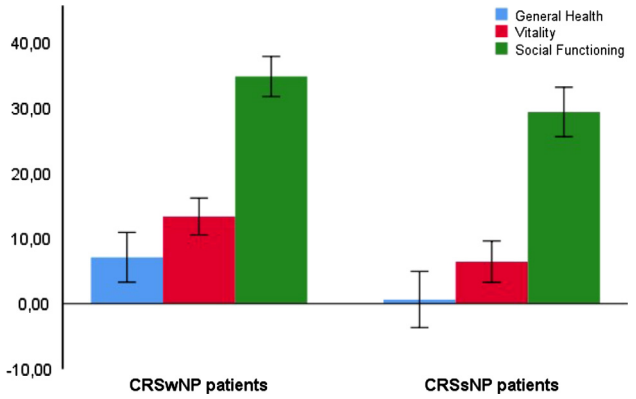

Fig. 1. Improvement in general health, vitality, and social functioning 6 months after surgery. Presented with mean values and 95% confidence interval of SF-36 domains. CRSsNP = chronic rhinosinusitis patients without nasal polyps; CRSwNP = chronic rhinosinusitis patients with nasal polyp.

scores improved in a statistically (P = .001) and clinically significant way, with no significant differences in the improvement between groups. CRSwNP patients had better postoperative score in the rhinologic subset compared to CRSsNP patients ($P \leq .033$).

Symptoms on VAS Before and After Surgery

Preoperatively, CRSwNP patients reported significantly more nasal obstruction, altered sense of smell, and nasal discharge compared with CRSsNP patients ($P \leq .009$) (Table IV). CRSsNP patients reported significantly greater facial pain and pressure in the sinuses compared with CRSwNP patients (P = .001). Six months after surgery, both patient groups had a statistically (P = .001) and clinically significant improvement in all symptoms, where CRSwNP patients had greater improvement in nasal obstruction and altered sense of smell compared to CRSsNP patients, who had greater improvement in facial pain ($P \leq .006$).

Patient Factors Associated with Improvement in HRQOL After Surgery

Univariable analysis identified age, sex, smoking, allergy, asthma, previous sinus surgery, and the preoperative value of the dependent variable as significantly associated with HRQOL outcomes. These variables were included in the multivariable analysis (Table V).

In the multivariable analysis, the preoperative value of the dependent variable was consistently associated with HRQOL improvement; worse preoperative SF-36 scores were associated with greater improvement in these outcomes in both groups.

Age, smoking, and previous sinus surgery were significantly associated with less improvement in two or several domains in both groups, in addition to female sex and allergy in the CRSsNP group.

In regard to SNOT-20, worse preoperative SNOT 20 scores were also associated with greater improvement

TABLE III.
Disease-Specific HRQOL Before and 6 Months After Surgery.

	CRSwNP Pre n = 220	CRSwNP Post n = 220	Improvement	CRSsNP Pre n = 196	CRSsNP Post n = 196	Improvement	Difference Pre-value	Difference Post-value	Difference Improvement
SNOT-20	2.18	1.24	0.93**	2.20	1.28	0.93**	0.03	0.03	0.01
	[2.06–2.29]	[1.13–1.36]	[0.82–1.05]	[2.08–2.32]	[1.15–1.40]	[0.80–1.06]	[−0.19 to 0.14]	[−0.14 to 0.20]	[−0.17 to 0.18]
Rhinologic subset	2.77	1.66	1.11**	2.38	1.45	0.93**	0.39**	0.21*	0.18
	[2.65–2.89]	[1.52–1.80]	[0.97–1.25]	[2.23–2.52]	[1.31–1.58]	[0.78–1.08]	[0.21–0.58]	[0.18–0.41]	[−0.02 to 0.38]
Ear/face subset	1.85	1.07	0.79**	2.08	1.17	0.91**	0.23*	0.11	0.12
	[1.70–2.00]	[0.93–1.20]	[0.66–0.91]	[1.93–2.23]	[1.03–1.31]	[0.75–1.06]	[−0.44 to −0.01]	[−0.09 to 0.30]	[−0.08 to 0.32]
Sleep function	1.96	1.06	0.89**	2.11	1.26	0.85**	0.16	0.20	0.05
	[1.77–2.14]	[0.91–1.22]	[0.72–1.07]	[1.92–2.30]	[1.08–1.45]	[0.67–1.03]	[−0.11 to 0.42]	[−0.04 to 0.44]	[−0.21 to 0.30]
Psychologic subset	1.89	1.00	0.89**	2.09	1.13	0.97**	0.20	0.13	0.08
	[1.73–2.06]	[0.85–1.15]	[0.74–1.05]	[1.92–2.27]	[0.97—1.28]	[0.80–1.14]	[−0.04 to 0.44]	[−0.09 to 0.34]	[−0.15 to 0.30]

Data are the mean with confidence intervals (CIs) of SNOT-20.
*$P \leq .05$.
**$P \leq .01$.
CRS = chronic rhinosinusitis; Difference = difference between CRS groups; Post = postoperatively; Pre = preoperatively.

TABLE IV.
Symptoms Before and 6 Months After Surgery.

	CRSwNP Pre $n = 220$	CRSwNP Post $n = 220$	Improvement	CRSsNP Pre $n = 196$	CRSsNP Post $n = 196$	Improvement
Nasal obstruction	73.9	32.8	41.1**	62.7	31.5	31.1**
	[70.6–77.1]	[29.1–36.5]	[36.4–45.8]	[58.9–66.4]	[27.9–35.2]	[26.6–35.7]
Facial pain	23.7	8.14	15.6**	41.7	17.6	24.0**
	[19.9–27.5]	[6.04–10.3]	[12.0–19.3]	[37.1–46.3]	[14.1–21.0]	[19.3–28.7]
Sinus pressure	48.8	19.5	29.4**	59.8	24.9	35.0**
	[44.4–53.2]	[16.2–22.8]	[24.7–34.0]	[55.9–63.6]	[21.0–28.7]	[30.2–39.8]
Altered sense of smell	70.8	36.3	34.5**	40.2	17.3	22.5**
	[66.3–75.2]	[31.5–41.1]	[29.4–39.7]	[35.4–45.0]	[14.1–20.6]	[17.6–27.4]
Nasal discharge	66.3	38.1	28.3**	58.4	35.7	23.2**
	[62.3–70.3]	[34.1–42.2]	[23.6–33.1]	[53.9–62.9]	[31.2–40.1]	[18.3–28.0]

Data are the mean with confidence intervals (CIs) assessed with VAS.
**$P \leq .01$.
Post = postoperatively; Pre = preoperatively; VAS = visual analog scale.

in SNOT 20 in both groups. Only having previous sinus surgery in the CRSsNP group was associated with less improvement in the rhinologic, sleep and psychological subsets (data not shown).

DISCUSSION

Our study showed that both patient groups reported improvement in all domains of generic HRQOL, except for general health in the CRSsNP group, 6 months after surgery. CRSwNP patients had greater improvement in general health, vitality and social function, and better postoperative score in physical role and bodily pain, vitality, and social functioning, compared with those domains in CRSsNP patients.

Our results are supported by data from Djukic and colleagues, who also showed improvement in generic HRQOL in CRSwNP patients after FESS,[4] and Ragab and coworkers, who found improvement in generic HRQOL in CRSwNP and CRSsNP patients after surgery.[7] Even so, a study by Smith and colleagues in CRS patients with no subgroup differentiation reported improvement in generic HRQOL after FESS.[14]

There could be several explanations for the differences in improvement documented in generic HRQOL between the two groups. The worse preoperative baseline in general health for CRSwNP patients and worse physical role and bodily pain in CRSsNP patients may contain different potentials for improvement. However, the greater improvement in vitality and social function in CRSwNP patients were not influenced by a worse preoperative baseline. This hypothesis may suggest that FESS has a greater beneficial impact on HRQOL in CRSwNP patients compared with CRSsNP patients. Both groups achieved a statistically significant improvement in approximately all generic domains after surgery, where a clinically significant improvement (i.e., half SD of the baseline value)[23] was found in vitality, social function, and mental health in both groups, as well as in general health in the CRSwNP group and physical role and bodily pain in the CRSsNP group. General health in the CRSsNP group was not improved 6 month after surgery; we do not have a firm explanation for this. We may suspect that sinus surgery is less likely to impact the general health domain of CRSsNP patients. The higher prescore of general health in the CRSsNP group may cause less potential for improvement compared with the CRSwNP group.

Furthermore, CRSsNP patients reported worse problems preoperatively in physical role and bodily pain compared with those reported by CRSwNP patients. A study by Sahlstrand-Johnsen and coworkers also reported more bodily pain in CRSsNP patients compared with bodily pain in CRSwNP patients.[29] A review by Chester and colleagues stated that bodily pain is underestimated in CRS patients.[30] It is not unlikely that bodily pain affects the perception of CRSsNP patients of their physical role. Hence, regardless of greater improvement in physical role after surgery, CRSsNP patients continued to have a worse postoperative score compared with that of CRSwNP patients. These findings may suggest that handling CRSsNP patients may be challenging, and that the surgical outcome in these patients may be more difficult to anticipate.

Compared with normative data from the Norwegian general population, our groups reported lower scores in all domains of SF-36 6 months after surgery.[31,32] These findings necessitate further attention with regard to the expectations of outcome, as they show the burden of CRS on generic HRQOL, and may indicate that medical treatment is also important postoperatively.

The comparison of generic HRQOL with normative data from the general Norwegian population is based on published data, probably using SF-36 v1, so the conclusions from this comparison should be drawn with caution.

SNOT-20 scores improved in both groups after surgery, a finding that is in accordance with results from other studies.[7,33] The mean improvement in SNOT-20 score in both groups was ≥0.08, which is considered a clinically significant improvement.[11] In the CRSwNP group,

TABLE V.
Multivariable Regression Model of Patient Factors Associated With Improvement in Eight Domains of SF-36.

CRSwNP	Physical Functioning B, [CI]	Role Physical B, [CI]	Bodily Pain B, [CI]	General Health B, [CI]	Vitality B, [CI]	Social Functioning B, [CI]	Role Emotional B, [CI]	Mental Health B, [CI]
Age	−.229*	−.277*	−.230*	.045	.143	−.151	−.150	.008
	[−.380 to −.078]	[−.473 to −.080]	[−.447 to −.013]	[−.182 to .273]	[−.037 to .323]	[−.364 to .063]	[−.318 to .018]	[−.114 to .129]
Sex	.678	3.56	1.94	−4.28	4.83	2.45	−1.21	−.563
	[−.4.06 to 5.42]	[−2.66 to 9.78]	[−5.02 to 8.90]	[−11.5 to 2.91]	[−.863 to 10.5]	[−4.31 to 9.21]	[−6.50 to 4.08]	[−4.43 to 3.30]
Allergy	−.386	−2.21	−.463	1.68	−1.61	−1.68	−1.02	−2.96
	[−4.82 to 4.05]	[−8.03 to 3.60]	[6.90 to 5.97]	[−5.05 to 8.41]	[6.96 to 3.74]	[−8.12 to 4.75]	[−6.50 to 4.08]	[−6.58 to .649]
Asthma	−.762	−2.53	2.54	−1.27	2.18	.833	.345	2.88
	[−5.57 to 4.04]	[−8.77 to 3.70]	[−4.29 to 9.38]	[−8.44 to 5.90]	[−3.47 to 7.83]	[−5.89 to 7.56]	[−4.92 to 5.61]	[−.974 to 6.73]
Previous sinus surgery	−1.30	−.533	−2.29	−10.1*	−4.83	−2.50	−2.03	−3.71*
	[−5.76 to 3.17]	[−6.39 to 5.12]	[−8.77to 4.19]	[−16.9 to −3.33]	[−10.2 to .559]	[−8.85 to 3.86]	[−7.01 to 2.95]	[−7.34 to −.096]
Smoking	−2.81	−10.3*	−6.55	9.52	−.131	−5.85	−12.0*	−2.94
	[−10.6 to 4.97]	[−20.5 to −.087]	[−17.8 to 4.74]	[−2.31 to 21.4]	[−9.48 to 9.22]	[−16.9 to 5.23]	[−20.6 to −3.27]	[−9.31 to 3.43]
Preoperative value	−.511**	−.513**	−.433**	−1.38**	−1.16**	−.879**	−.676**	−.857**
	[−.621 to −.400]	[−.622 to −.405]	[−.552 to −.313]	[−1.68 to −1.09]	[−1.48 to −.837]	[−1.27 to −.490]	[−.771 to −.580]	[−1.10 to −.616]
CRSsNP								
Age	−.170*	−.163	−.257*	.174	.134	.010	.050	.097
	[−.301 to −.039]	[−.393 to .067]	[−.504 to −.011]	[−.069 to .418]	[−.059 to .327]	[−.256 to .236]	[−.249 to .149]	[−.032 to .227]
Sex	−1.60	.285	−7.41*	−.320	−1.67	−.579	2.22	−1.39
	[−.5.55 to 2.35]	[−6.58 to 7.15]	[−14.8 to −.007]	[−7.02 to 7.66]	[−7.45 to 4.11]	[−7.96 to 6.80]	[−3.73 to 8.16]	[−5.27 to 2.50]
Allergy	.279	−2.86	2.94	−7.75*	−7.60*	−7.64	−2.45	−5.96*
	[−3.72 to 4.27]	[−9.88 to 4.16]	[−4.57 to 10.4]	[−15.2 to −.327]	[−13.5 to −1.68]	[−15.1 to −.158]	[−8.51 to 3.60]	[−9.90 to −2.03]
Asthma	.261	−6.61	−.377	−5.83	−2.79	−.535	−5.50	.611
	[−4.87 to 5.39]	[−15.6 to 2.37]	[−10.0 to 9.27]	[−15.4 to 3.73]	[−10.4 to 4.80]	[−10.2 to 9.08]	[−13.3 to 2.26]	[−4.44 to 5.66]
Previous sinus surgery	−5.03*	−5.86	−8.71*	−8.51*	−5.11	−9.54*	−4.62	−5.60*
	[−9.06 to −1.02]	[−12.9 to 1.17]	[−16.3 to −1.15]	[−16.0 to −1.03]	[−11.0 to .817]	[−17.1 to −1.97]	[−10.7 to 1.49]	[−9.56 to −1.64]
Smoking	.430	−2.14	−.520	−13.5*	−9.43*	−6.12	−6.53	−4.33
	[−5.32 to 6.18]	[−12.2 to 7.93]	[−11.5 to 10.4]	[−24.1 to −2.93]	[−17.8 to −1.04]	[−16.9 to 4.61]	[−15.2 to 2.12]	[−9.97 to 1.30]
Preoperative value	−.465**	−.618**	−.605**	−1.43**	−1.19**	−1.00**	−.711**	−.622**
	[−.567 to −.363]	[−.740 to −.496]	[−.756 to −.454]	[−1.72 to −1.14]	[−1.49 to −.900]	[−1.36 to −.647]	[−.821 to −.602]	[−.876 to −.368]

In CRSwNP group, the n in the analysis varies from 209 to 220, and in CRSsNP group, the *n* varies from 180 to 192.
*$P \leq .05$.
**$P \leq .01$.
B = unstandardized coefficient; CI = confidence interval.

53% of patients and 47% in the CRSsNP group reached a clinically significant improvement. Nevertheless, the mean postoperative scores in both groups were ≥1.2, which were considerably worse than the score of 0.4 reported in people without CRS.[34] We found no significant differences in the improvement of disease-specific HRQOL between the groups. In a study by Hopkins and coworkers using SNOT-22, CRSwNP patients reported greater improvement after surgery compared to CRSsNP patients.[35] The reason for the different results in our study may be that SNOT-20 does not contain questions on nasal obstruction and olfactory function. Hence, SNOT-22 would be more sensitive for measuring improvement in the CRSwNP group, but a Norwegian version of SNOT-22 was not available when the present study started. Nevertheless, our results from SF-36 support the findings from Hopkins study.[35]

Preoperatively, CRSwNP patients reported greater nasal obstruction, altered sense of smell, and nasal discharge, whereas CRSsNP patients reported more facial pain and pressure in the sinuses, data that are in line with results from other studies.[8,36] After surgery, CRSwNP patients reported greater reduction of nasal obstruction and greater improvement in olfactory function compared to CRSsNP patients, whereas CRSsNP patients had a greater reduction of facial pain compared to CRSwNP patients. Thus, our findings are in line with Andrews and colleagues results, CRSwNP patients had a worse altered sense of smell preoperatively followed by greater improvement 6 months after surgery compared with that in CRSsNP patients.[6]

Although sinus surgery led to symptom relief and improved disease-specific and generic HRQOL in both patient groups, SF-36 revealed a dissimilarity in improvement between patient groups. Patients with CRSwNP had a greater improvement in general health, vitality, and social function than patients with CRSsNP. This information may help surgeons in counseling patients about expectations of generic HRQOL outcome and emphasize that CRSsNP may be a more complex condition than CRSwNP.

Thus, we believe that the generic HRQOL should be taken into account to understand how it changes after patients undergo surgery for CRS.

Our study found that older age was associated negatively with improvement in physical function and bodily pain in both groups. We have not found other studies suggesting age to be associated with SF-36 outcome in CRS patients. However, a study by Reh and coworkers comparing an older and younger cohort of CRS patients did not find differences in disease-specific HRQOL outcome after FESS,[37] whereas Hopkins and colleagues found older age to be one of several factors associated with disease-specific HRQOL outcome after FESS.[35] It is not surprisingly that age is associated with these domains, but it should be considered for the total preoperative assessment of a CRS patient. Previous sinus surgery was also associated with less improvement in general and mental health in both groups, in addition to physical functioning, bodily pain, and social function in CRSsNP patients. This difference may indicate that revision surgery has more negative impact on HRQOL improvement in CRSsNP patients compared to CRSwNP patients. In the CRSsNP group, having allergy seemed to have a major negative impact on generic HRQOL, emphasizing the importance of allergy testing and optimal allergy treatment.

With regard to SNOT-20, increased preoperative nasal obstruction was associated with better outcome in the rhinologic subset for the CRSwNP group. This observation is supported by data from a study by Hopkins and coworkers using SNOT-22. They found that a more severe preoperative value indicated a greater absolute reduction.[35] Smith and colleagues, using the Rhinosinusitis Disability Index and Chronic Sinusitis Survey, found similar results, whereby a worse baseline value was associated with greater improvement after surgery.[17] Unfortunately, comparison of our study results with that of other reports is difficult because they used different instruments, and one study did not differentiate between CRS with and without polyps.

One limitation of our study is that the SNOT-20 questionnaire does not have questions about nasal obstruction and olfactory function. This may explain why we did not find differences between the two patient groups regarding disease-specific HRQOL. The patients were prescribed nasal steroid spray postoperatively, but due to the extensiveness of the sinonasal disease and the steroidresponsiveness of nasal polyps, CRSwNP patients were put on a postoperative medication regime with additional fluticasone nasal drops. We do not know if this difference in postoperative treatment have influence on the results. Our results are not adjusted for the baseline differences between the groups which may have importance for the outcome in both groups, nor did we analyze the outcomes based on extent of surgery or the variety of surgeons. The aim of this prospective registry study was to examine HRQOL in CRS patients who underwent sinus surgery in our daily practice at a tertiary hospital.

The strengths of our study were its prospective design, relatively large sample size, high follow-up (90%), differentiation between CRS patients with and without polyps, and that we investigated disease-specific and generic HRQOL.

CONCLUSION

CRSwNP and CRSsNP patients reported improved generic and disease-specific HRQOL after FESS. CRSwNP patients reported greater improvement in the SF-36 domains of general health, vitality, and social function compared to CRSsNP patients. This may indicate a greater potential for HRQOL improvement in CRSwNP patients compared to CRSsNP patients. Higher age, smoking, and previous surgery were associated with less improvement in generic HRQOL in both groups. In addition, female sex and having allergy was associated with less improvement in generic HRQOL in the CRSsNP group, but not in the CRSwNP group.

ACKNOWLEDGMENTS

The authors thank the nurses at the outpatient clinic at the ENT Department at St Olav's University hospital and the Unit for Applied Research (AKF) at the Norwegian University of Science and Technology (NTNU) for assisting in registry data management. The Liaison Committee between St Olav's University hospital and the Faculty of Medicine and Health, NTNU was the main founding contributor to this study.

AUTHOR CONTRIBUTIONS

A.H.N.: Study design, data collection, statistical analysis, and paper drafting. A.S.H.: Study design, statistical analysis, and paper drafting. W.M.T.: Study design, data collection, statistical analysis, and paper drafting. Ø.S.: Statistical analysis and paper drafting. V.B.: Study design, data collection, statistical analysis, and paper drafting.

BIBLIOGRAPHY

1. Chaaban MR, Walsh EM, Woodworth BA. Epidemiology and differential diagnosis of nasal polyps. *Am J Rhinol Allergy* 2013;27:473–478.
2. Jarvis D, Newson R, Lotvall J, et al. Asthma in adults and its association with chronic rhinosinusitis: the GA2LEN survey in Europe. *Allergy* 2012; 67:91–98.
3. Shashy RG, Moore EJ, Weaver A. Prevalence of the chronic sinusitis diagnosis in Olmsted County, Minnesota. *Arch Otolaryngol Head Neck Surg* 2004;130:320–323.
4. Djukic V, Dudvarski Z, Arsovic N, Dimitrijevic M, Janosevic L. Clinical outcomes and quality of life in patients with nasal polyposis after functional endoscopic sinus surgery. *Eur Arch Otorhinolaryngol* 2015;272:83–89.
5. Beswick DM, Mace JC, Soler ZM, et al. Appropriateness criteria predict outcomes for sinus surgery and may aid in future patient selection. *Laryngoscope* 2018;128:2448–2454.
6. Andrews PJ, Poirrier AL, Lund VJ, Choi D. Outcomes in endoscopic sinus surgery: olfaction, nose scale and quality of life in a prospective cohort study. *Clin Otolaryngol* 2016;41:798–803.
7. Ragab SM, Lund VJ, Scadding G, Saleh HA, Khalifa MA. Impact of chronic rhinosinusitis therapy on quality of life: a prospective randomized controlled trial. *Rhinology* 2010;48:305–311.
8. Bugten V, Nordgard S, Romundstad P, Steinsvag S. Chronic rhinosinusitis and nasal polyposis; indicia of heterogeneity. *Rhinology* 2008;46:40–44.
9. Prasad S, Fong E, Ooi EH. Systematic review of patient-reported outcomes after revision endoscopic sinus surgery. *Am J Rhinol Allergy* 2017;31:248–255.
10. Rudmik L, Hopkins C, Peters A, Smith TL, Schlosser RJ, Soler ZM. Patient-reported outcome measures for adult chronic rhinosinusitis: a systematic review and quality assessment. *J Allergy Clin Immunol* 2015;136:1532–1540.e1532.
11. Piccirillo JF, Merritt MG Jr, Richards ML. Psychometric and clinimetric validity of the 20-Item Sino-Nasal Outcome Test (SNOT-20). *Otolaryngol Head Neck Surg* 2002;126:41–47.
12. Quintanilla-Dieck L, Litvack JR, Mace JC, Smith TL. Comparison of disease-specific quality-of-life instruments in the assessment of chronic rhinosinusitis. *Int Forum Allergy Rrhinol* 2012;2:437–443.
13. Noon E, Hopkins C. Review article: outcomes in endoscopic sinus surgery. *BMC Ear Nose Throat Disord* 2016;16:9.
14. Smith TL, Litvack JR, Hwang PH, et al. Determinants of outcomes of sinus surgery: a multi-institutional prospective cohort study. *Otolaryngol Head Neck Surg* 2010;142:55–63.
15. Katotomichelakis M, Simopoulos E, Tripsianis G, et al. Predictors of quality of life outcomes in chronic rhinosinusitis after sinus surgery. *Eur Arch Otorhinolaryngol* 2014;271:733–741.
16. Kennedy JL, Hubbard MA, Huyett P, Patrie JT, Borish L, Payne SC. Sino-nasal outcome test (SNOT-22): a predictor of postsurgical improvement in patients with chronic sinusitis. *Ann Allergy Asthma Immunol* 2013;111: 246–251.e242.
17. Smith TL, Mendolia-Loffredo S, Loehrl TA, Sparapani R, Laud PW, Nattinger AB. Predictive factors and outcomes in endoscopic sinus surgery for chronic rhinosinusitis. *Laryngoscope* 2005;115:2199–2205.
18. Rimmer J, Fokkens W, Chong LY, Hopkins C. Surgical versus medical interventions for chronic rhinosinusitis with nasal polyps. *Cochrane Database Syst Rev* 2014;12:Cd006991.
19. Fokkens WJ, Lund VJ, Mullol J, et al. EPOS 2012: European position paper on rhinosinusitis and nasal polyps 2012. A summary for otorhinolaryngologists. *Rhinology* 2012;50:1–12.
20. SF-36v2® Health Survey © 1994-2012. Medical Outcomes Trust and QualityMetric Incorporated. All rights reserved. S-iartoMO Trust. SF-36v2® Health Survey Standard NN. Short Form Health Survey 36, 2012.
21. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992;30: 473–483.
22. Ware JE Jr. In: MEE M, ed. *User's manual for the SF-36v2 Health Survey*. Lincoln, RI: QualityMetric Incorporated; 2011.
23. Norman GR, Sloan JA, Wyrwich KW. The truly remarkable universality of half a standard deviation: confirmation through another look. *Expert Rev Pharmacoecon Outcomes Res* 2004;4:581–585.
24. Browne JP, Hopkins C, Slack R, Cano SJ. The Sino-Nasal Outcome Test (SNOT): can we make it more clinically meaningful? *Otolaryngol Head Neck Surg* 2007;136:736–741.
25. Grant S, Aitchison T, Henderson E, et al. A comparison of the reproducibility and the sensitivity to change of visual analogue scales, Borg scales, and Likert scales in normal subjects during submaximal exercise. *Chest* 1999;116:1208–1217.
26. Bugten V, Nordgard S, Skogvoll E, Steinsvag S. Effects of nonabsorbable packing in middle meatus after sinus surgery. *Laryngoscope* 2006;116:83–88.
27. Bugten V, Nordgard S, Steinsvag S. The effects of debridement after endoscopic sinus surgery. *Laryngoscope* 2006;116:2037–2043.
28. Bugten V, Nordgard S, Steinsvag S. Long-term effects of postoperative measures after sinus surgery. *Eur Arch Otorhinolaryngol* 2008;265:531–537.
29. Sahlstrand-Johnson P, Ohlsson B, Von Buchwald C, Jannert M, Ahlner-Elmqvist M. A multi-centre study on quality of life and absenteeism in patients with CRS referred for endoscopic surgery. *Rhinology* 2011;49:420–428.
30. Chester AC, Sindwani R, Smith TL, Bhattacharyya N. Systematic review of change in bodily pain after sinus surgery. *Otolaryngol Head Neck Surg* 2008;139:759–765.
31. Garratt AM, Stavem K. Measurement properties and normative data for the Norwegian SF-36: results from a general population survey. *Health Qual Life Outcomes* 2017;15:51.
32. Jacobsen EL, Bye A, Aass N, et al. Norwegian reference values for the Short-Form Health Survey 36: development over time. *Qual Life Res* 2018;27:1201–1212.
33. Lee JY, Lee SW, Lee JD. Comparison of the surgical outcome between primary and revision endoscopic sinus surgery for chronic rhinosinusitis with nasal polyposis. *Am J Otolaryngol* 2008;29:379–384.
34. Thorstensen WM, Bugten V, Sue-Chu M, Fossland NP, Romundstad PR, Steinsvag SK. Sino-nasal characteristics in asthmatic patients. *Otolaryngol Head Neck Surg* 2012;147:950–957.
35. Hopkins C, Rudmik L, Lund VJ. The predictive value of the preoperative Sinonasal Outcome Test-22 score in patients undergoing endoscopic sinus surgery for chronic rhinosinusitis. *Laryngoscope* 2015;125:1779–1784.
36. Banerji A, Piccirillo JF, Thawley SE, et al. Chronic rhinosinusitis patients with polyps or polypoid mucosa have a greater burden of illness. *Am J Rhinol* 2007;21:19–26.
37. Reh DD, Mace J, Robinson JL, Smith TL. Impact of age on presentation of chronic rhinosinusitis and outcomes of endoscopic sinus surgery. *Am J Rhinol* 2007;21:207–213.