ISBN 978-82-326-4838-2 (printed ver.)
ISBN 978-82-326-4839-9 (electronic ver.)
ISSN 1503-8181

Ann Helen Nilsen

Doctoral thesis

Doctoral theses at NTNU, 2020:245

Ann Helen Nilsen

Health-related Quality of Life and Surgical Management of Nasal Obstruction and Chronic Rhinosinusitis

A register-based study on patients undergoing septoplasty, radiofrequency therapy of inferior turbinate, and functional endoscopic sinus surgery

NTNU
Norwegian University of Science and Technology
Thesis for the Degree of
Philosophiae Doctor
Faculty of Medicine and Health Sciences
Department of Neuromedicine and Movement Science

Doctoral theses at NTNU, 2020:245

NTNU

NTNU
Norwegian University of Science and Technology

NTNU
Norwegian University of Science and Technology

Ann Helen Nilsen

Health-related Quality of Life and Surgical Management of Nasal Obstruction and Chronic Rhinosinusitis

A register-based study on patients undergoing septoplasty, radiofrequency therapy of inferior turbinate, and functional endoscopic sinus surgery

Thesis for the Degree of Philosophiae Doctor

Trondheim, September 2020

Norwegian University of Science and Technology
Faculty of Medicine and Health Sciences
Department of Neuromedicine and Movement Science

NTNU
Norwegian University of
Science and Technology

NTNU
Norwegian University of Science and Technology

Thesis for the Degree of Philosophiae Doctor

Faculty of Medicine and Health Sciences
Department of Neuromedicine and Movement Science

ISBN 978-82-326-4838-2 (printed ver.)
ISBN 978-82-326-4839-9 (electronic ver.)
ISSN 1503-8181

Doctoral theses at NTNU, 2020:245

Printed by NTNU Grafisk senter

Norsk sammendrag

Pasienter med skjev neseskillevegg og forstørrede nesemuslinger plages ofte av kronisk nesetetthet som igjen kan føre til munnpusting, snorking og forstyrret søvn. Kronisk nesetetthet er også et vanlig symptom hos pasienter med kronisk bihulebetennelse, i tillegg andre symptomer som renning fra nesen, smerter og trykk i ansiktet og nedsatt luktesans. Plagene kan bli så store at det går ut over pasientenes livskvalitet og de søker legehjelp.
Mange av disse pasientene kan behandles med medikamenter, men hos noen anbefales også kirurgisk behandling.

Målet med operasjon av neseskilleveggen og nesemuslinger er å forbedre passasjen gjennom nesen slik at pasienten puster bedre gjennom nesen. Ved bihuleoperasjon fjernes eventuelle polypper og utførselsgangene fra bihulene utvides slik at puss og sekret lettere dreneres ut fra bihulene. Disse inngrepene er noen av de hyppigst utførte operasjonene innen fagområdet Øre-Nese-Hals.

For å vurdere hvilken effekt behandlingen har hatt på pasientenes plager må behandlingen evalueres. Dette kan gjøres ved å sammenligne pasientens symptomer og fysiske mål som nesens tverrsnittsareal og luftstrøm før og etter behandling. Ikke sjelden er det det manglende samsvar mellom symptomer og fysiske mål, noe som gjør vurderingen utfordrende.

Ved å inkludere målinger av pasientens *helserelaterte livskvalitet* (HRQOL) som et supplement i evalueringen, kan man få et mer helhetlig bilde av hvordan kirurgisk behandling påvirker fysiske, psykiske og sosiale områder i pasientens liv.

HRQOL kan defineres som pasientens egne (subjektive) erfaringer knyttet til sin helse, sykdom og funksjonsnedsettelse, og effekten av behandling. Anvendelsen av HRQOL-målinger, som et supplement til kliniske funn, symptomer og fysiske målinger er økende internasjonalt, men er ikke rutinemessig i bruk i evaluering av nese- og bihulekirurgi i Norge.

Målet med avhandlingen var å undersøke symptomer og HRQOL, samt minste tverrsnittsareal, volum og luftstrøm hos pasienter som ble operert for skjev neseskillevegg, forstørrede nesemuslinger eller kronisk bihulebetennelse med og

uten nesepolypper før og 6 måneder etter behandling. Data brukt i studiene er hentet fra et lokalt Kvalitetsregister ved ØNH-avdelingen ved St Olavs Hospital.

I artikkel 1 og 2 undersøkte vi tre pasientgrupper. 1: Pasienter som fikk operert neseskilleveggen. 2: Pasienter som fikk operert både neseskilleveggen og nesemuslingene (RFIT). 3: Pasienter som fikk operert bare RFIT.

I artikkel 1 beskrives forbedring i symptomer og i *sykdomsspesifikk*- og i enkelte områder i *generell* HRQOL i alle grupper. Gruppen som fikk operert både neseskillevegg og nesemuslinger rapporterte større forbedring i *sykdomsspesifikk* HRQOL enn RFIT-gruppen. Dette antyder at gruppene som fikk operert neseskilleveggen hadde noe bedre effekt av behandlingen enn RFIT-gruppen.

I artikkel 2 undersøkte vi de samme pasientene i forhold til nesens minste tverrsnittsareal (MCA) og volum (NCV) på to områder inne i nesen (0-3 cm og 3-5 cm fra neseborene). I tillegg målte vi maksimal luftstrøms-hastighet gjennom nesen. Gruppene som fikk operert neseskilleveggen hadde mindre MCA på den trangeste siden fremst i nesen enn RFIT-gruppen før operasjon.

MCA og NCV ble større i begge områdene i nesen hos gruppene som fikk operert neseskilleveggen, mens hos RFIT-gruppen økte MCA og NVC i området 3-5 cm. Luftstrøms-hastigheten forbedret seg likt i alle gruppene. Resultatene tyder på at de 3 ulike inngrepene påvirker MCA og NCV på ulike områder i nesen, men at inngrepene har lik effekt på luftstrøms-hastigheten i våre pasientgrupper. Vi undersøkte også hvordan de fysiske målingene samsvarte med pasientenes subjektive nesetetthet, og fant at økt MCA og NCV samsvarte med mindre subjektiv nesetetthet etter kirurgi i gruppen som fikk operert kun neseskilleveggen.

I artikkel 3 undersøkte vi symptomer og HRQOL i to pasientgrupper med kronisk bihulebetennelse, med og uten nesepolypper, som gjennomgikk bihulekirurgi. Før operasjonen rapporterte gruppen med nesepolypper mere nesetetthet og nedsatt luktesans enn gruppen uten nesepolypper som rapporterte mer ansiktssmerter og press i bihulene. Begge gruppene oppnådde forbedring i symptomer, sykdomsspesifikk- og generell HRQOL. Gruppen med nesepolypper rapporterte større forbedring i generell HRQOL i aspekter som omhandler generell helse, vitalitet og sosial fungering enn gruppen uten nesepolypper. Økende alder, daglig røyking og

tidligere bihulekirurgi var assosiert med mindre forbedring i generell HRQOL i begge gruppene, i tillegg til kvinnelig kjønn og allergi i gruppen uten nesepolypper.

Avhandlingen konkluderer med at den kirurgiske behandlingen fører til forbedring av symptomer og HRQOL, men at de kirurgiske inngrepene og ulike karakteristika hos pasientene ser ut til å virke inn på graden av forbedring. Ved å måle både sykdomsspesifikk- og generell HRQOL har vi identifisert ulike HRQOL-områder hos pasientene som har endret seg etter den kirurgiske behandlingen. Resultatene fra de fysiske målingene har gitt oss nyttig informasjon om hvor i nesekaviteten økningen i MCA skjer, noe som kan ha betydning for valg av kirurgisk prosedyre.

Avhandlingen viser at måling av symptomer og HRQOL, i tillegg til fysiske målinger og kliniske funn, kan gi helhetlig kunnskap om pasienten både før og etter behandling. Denne kunnskapen kan bidra til riktig valg av behandling, realistiske forventninger til effekt av behandlingen og bedre utnyttelse av begrensede helseressurser.

Navn kandidat: Ann Helen Nilsen
Institutt: Institutt for nevromedisin og bevegelse, NTNU
Veileder(e): Vegard Bugten, Anne-Sofie Helvik og Wenche Moe Thorstensen
Finansieringskilde: ØNH-avdelingen ved St. Olavs hospital og Felles Forskningsutvalg for St. Olavs hospital og Fakultetet for medisin og helsevitenskap

Content

Acknowledgments

This work has been carried out at the Department of Ear, Noes and Throat, Head and Neck Surgery (ENT) at St. Olavs University hospital and the Institute of Neuroscience and Movement at the Norwegian University of Science and Technology (NTNU). The research in this thesis was supported by a grant from the Joint Research Committee between St. Olavs Hospital and the Faculty of Medicine and Health Sciences, NTNU.

Getting into research has been an exciting, challenging and very stimulating journey for me. I would like to thank all the people who have made the research in this thesis possible and all who have contributed to this journey in their own particular way.

First, I would like to express my sincere gratitude to the patients who participated in the “Nose-and Sinus”-register at the ENT dept. at St.Olavs hospital, where the data used in this thesis derive from.

I am grateful to my primary supervisor Vegard Bugten for the opportunity to study important patient outcomes from our daily practice and develop as an researcher. Although immensely hardworking and engaged in many projects both clinically and in research, he was always available, with a smile, when I needed discussions, help and feedback.

I would also like to express a special gratitude to my inspiring co-supervisor Professor Anne-Sofie Helvik, for sharing her broad and profound knowledge and experience in medical research and research methods. My co-supervisor Wenche Moe Thorstensen for showing great interest and making important contributions to this project. Professor Ståle Nordgård deserves a particular mention for introducing

me to medical research and his always positive attitude towards professional development and interdisplinary research cooperation. Also Head of department Mette Bratt for enthusiasm and interesting discussions. Berit Bjelkåsen and Øyvind Salvesen for assistance in datamanagement and statistics.

A sincere gratitude and respect to all personell at the ENT department involved in patient care, data collection and logistic of Patient-folders, especially to my dedicated colleges at the outpatient clinic led by Hanne Kvalvik. Tove and all the nurses for continuous support, and Else for our interesting conversations.

Most of all, I must thank my dear husband Gabriel, our three sons Adrian, Andreas and Erlend with families, my mother, my brothers with families and our good friends for support and encouragement.

List of papers

Paper 1.

A comparison of symptoms and quality of life before and after nasal septoplasty and radiofrequency therapy of the inferior turbinate.

Nilsen AH, Helvik AS, Thorstensen WM, Bugten V.

BMC Ear Nose Throat Disord. 2018 Jan 26;18:2. doi: 10.1186/s12901-017-0050-z. eCollection 2018.

Paper 2.

Improvement in minimal cross-sectional area and nasal cavity volume occurs in different areas after septoplasty and radiofrequency therapy of inferior turbinates.

Nilsen AH, Thorstensen WM, Helvik AS, Nordgård S, Bugten V.

Eur Arch Otorhinolaryngol. 2018 Aug;275(8):1995-2003. doi: 10.1007/s00405-018-5022-4. Epub 2018 Jun 5.

Paper 3.

General health, vitality, and social function after sinus surgery in chronic rhinosinusitis.

Ann Helen Nilsen, Anne-Sofie Helvik, Wenche Moe Thorstensen, Øyvind Salvesen, Vegard Bugten.

Laryngoscope Investig Otolaryngol. 2019 Aug 12;4(5):476-483. doi: 10.1002/lio2.299. eCollection 2019 Oct

Acronyms and abbreviations

AR: Acoustic rhinometry

ASA: Acetylsalicylic acid

BMI: Body mass index

BP: Bodily pain domain

CI: Confidence interval

CRS: Chronic rhinosinusitis

CRSwNP: Chronic rhinosinusitis with nasal polyps

CRSsNP: Chronic rhinosinusitis without/sin nasal polyps

CT: Computer tomography

ENT: Ear, nose, and throat

EPOS: European position paper of rhinosinusitis and nasal polyps

GH: General health domain

HRQOL: Health-related quality of life

IT: Inferior turbinate

ITH: Inferior turbinate hypertrophy

MCA: Minimal cross-sectional area

MCID: Minimal clinically important difference

MH: Mental health domain

MID: Minimal important difference

MRI: Magnet resonance imaging

NCV: Nasal cavity volume

NP: Nasal polyps

NTNU: Norwegian University of Technology and Science

PASW: Predictive analytic software

PF: Physical functioning domain

PNIF: Peak nasal inspiratory flow

Pre: Preoperatively

PROMs: Patient reported outcome measures

Post: Postoperatively

QOL: Quality of life

RE: Role emotional domain

RFIT: Radiofrequency therapy of inferior turbinate

RP: Role physical domain

SD: Standard deviation

SF: Social function

SF-36: Short-Form Health Survey-36

SNO: Subjective nasal obstruction

SNOT-20: Sino-Nasal Outcome Test-20

SPSS: Statistical Package for the Social Sciences

VAS: Visual analog scale

VT: Vitality domain

1 Introduction

1.1 Topic

This dissertation examines symptoms and health-related quality of life (HRQOL) in patients who undergo surgery in the nose and paranasal sinuses due to nasal septum deviation, hypertrophy of inferior turbinate (ITH), or chronic rhinosinusitis with and without nasal polyps (CRSwNP, CRSsNP).

Also, nasal geometry and airflow are examined in the patients with nasal septum deviation and ITH.

1.2 Rationale

Surgical treatment of septum deviation, ITH, or CRS with and without nasal polyps (NP) is frequently utilized with a variety of effect on different outcomes. The overall goal of the surgery is to improve symptoms of nasal obstruction, nasal discharge, facial pain, loss of smell, and reduce mucosal inflammation in order to improve the patient's HRQOL.

The evaluation of surgical outcomes is challenging because the clinical diagnosis is based on the patient`s subjective feelings, examination findings, and the surgeon's assessment. There are no ideal tests, for example, for nasal breathing that can translate the patient`s evaluation of nasal obstruction into a specific figure, as is the case with the audiogram for hearing, the vision test for sight, and spirometry for lung function (1).

Acoustic rhinometry (AR) and peak nasal inspiratory airflow (PNIF) may contribute to additional information of the nasal area, volumes, and airflow, although these methods frequently do not correlate strongly with the patient's subjective feeling (2).

The surgical treatment is focused on the anatomic source of the symptoms as determined by the surgeon, but the ultimate test of a successful treatment is the patient's reported relief of, for example, nasal obstruction and how this affects the patient's HRQOL (3). Thus, patient-reported outcome measures (PROMs), such as symptoms and HRQOL, have become increasingly important tools in the evaluation of surgical treatment in the nose and paranasal sinuses.

To assess and secure the quality of surgical treatment of patients receiving surgery in the nose and paranasal sinuses in our department, symptoms, HRQOL, nasal geometry, and airflow are registered at two time points, before surgery and six months after.

2 Background

2.1 Anatomy and physiology of the nose and paranasal sinuses

2.1.1 The nose

The nose is the entrance to the airway and has multiple functions as a passageway for airflow, chemosensor for olfaction, an air conditioner, and as the first line of defense against respiratory infection (4). The human nose is divided into the external nose and the nasal cavity with two anatomically distinct passageways, each with a separate blood supply and nerve pathways. The external nose consists of an upper part of nasal bones connected with the forehead and a lower part, which includes the upper lateral and lower lateral (alar) cartilages (5). The cartilages counteract collapse and provide rigidity for the nasal vestibule and alae regions during respiration.

The internal nose with the nasal cavity being the first part of the airway, is divided by the nasal septum, which includes a cartilaginous and a bony part, lined by respiratory mucosa.

From the lateral nasal wall, three turbinates arise: the inferior, middle, and superior turbinate. The turbinates consist of a bony core coated with respiratory mucosa with a cavernous erectile tissue, mostly developed in the inferior turbinate. Thus, this turbinate and the erectile tissue on the septal nasal walls contribute significantly to the regulation of airflow (6, 7). The mucosa warms and humidifies the inhaled air, filters particles, and is a part of the immune system which may react to stimulus, for example, as in hay fever (8).

The continually beating ciliated mucosa provides constant motion, which acts as a cleaning and filtering system for the upper respiratory tract. The turbinates maximize

the effective intranasal surface area for rapid humidification and warming of inspired air (9).

The external nasal valve is defined as the area in the vestibule under the nasal ala, formed by the caudal septum. The internal nasal valve is located approximately 1.3 cm from the nares and corresponds to the region under the upper lateral cartilages, bound medially by the dorsal septum, inferiorly by the head of the inferior turbinate, and laterally by the upper lateral cartilage (Figure 1). This is the narrowest point of the nasal passage (10) and is a dynamic valve where airway resistance is determined by the swelling and constriction of the venous sinuses of the inferior turbinate and septum (4). The nasal valve, with its external and internal components, has been described anatomically as the cross-sectional area of the nasal cavity with the greatest overall resistance to airflow acting as the dominant determinant for nasal inspiration (11).

As the air enters these narrow segments, acceleration occurs, leading to a drop in intraluminal pressure. This phenomenon tends to collapse the lateral nasal wall, where, for example, minor septum deviations and weakened soft tissues can have a significant impact on nasal airflow (11).

During normal breathing through the nose, approximately half of the total resistance of the airways is located in the nasal airway (12). A minimal decrease in the radius of the nasal airway will thus lead to a significant reduction in flow (13, 14).

The cross-sectional areas of the nasal cavity increase in an anterior-posterior direction (10). The area posterior to the nasal valve is the turbinate region where the nasal passage has a relatively large cross-sectional area compared to the nasal

valve area. In the normal nose, the turbinated area has only a minimal contribution to the airway resistance of a nasal passage (4).

The nasal airflow is constantly changing due to variations in the mucosa, ciliary function, vasoconstriction and vasodilatation, reflexes, and the nasal cycle. The nasal cycle is a spontaneous change in unilateral nasal airflow due to the congestion and decongestion of the venous sinuses every 3-7 hours (15). During a normal cycle, one nasal cavity is assumed to be in a “working phase,” while the opposite cavity is in a “resting phase,” which allows restoration of the mucosa. Ethnicity, developmental, and environmental differences provide a wide variety of skeletal and mucosal variations within the nasal cavity (10).

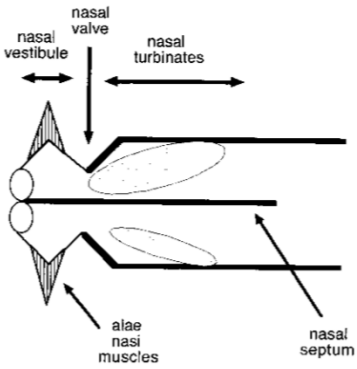

Figure 1: Diagram of the internal nose (with permission from Eccles).

2.1.2 The paranasal sinuses

The paranasal sinuses are air-filled extensions of the nasal cavity into the skull bones and are arranged in anterior and posterior groups (Figure 2). The anterior group consists of the frontal, anterior ethmoidal, and maxillary sinuses, which drain into the middle meatus. The posterior ethmoidal and sphenoid sinuses drain into the superior meatus and sphenoethmoidal recess. The crucial drainage area of the anterior group is called the ostiomeatal complex (5).

The function of the paranasal sinuses is suggested to be an aid to vocal resonance, a reduction of skull weight, protection of the eyes from trauma, and protection of vital intracranial structures (5). Also, nitric oxide (NO), which is involved in the regulation of the pulmonary function, is continuously produced in the paranasal sinuses (16).

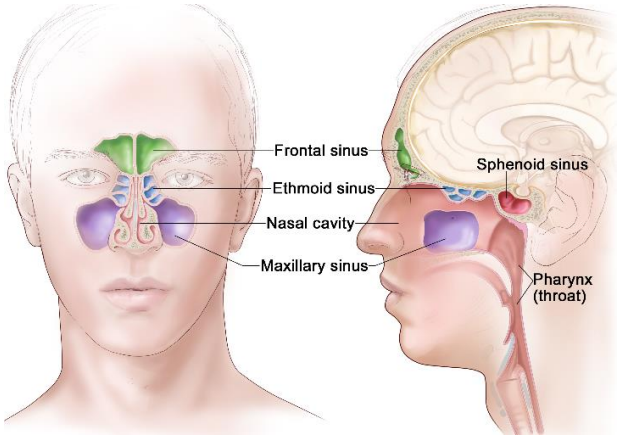

Figure 2: Nasal cavity and paranasal sinuses (T. Winslow 2012)

2.2 Three common benign conditions in the nose and paranasal sinuses

2.2.1 Septum deviation

Nasal septal deviation is a condition in which the nasal septum is significantly off-center or crooked, making nasal breathing difficult. Septum deviation is commonly congenital or acquired from trauma and has a prevalence ranging from 19 percent to 65 percent due to different definition criteria (17, 18). Unilateral nasal obstruction is the main complaint, although an s-shaped deviation can cause bilateral symptoms. The deviation may involve the bony or the cartilaginous regions, or both (5), and can be accompanied by hypertrophy of the turbinate contralateral to the

deviation (19). The reason for the compensatory hypertrophy is to protect the more patent (open) nasal side from drying and crusting effects of excess airflow (20).

Not every abnormality of the septum requires correction, as anterior deviations in the nasal valve region are more likely to cause symptoms of obstruction than posterior deviations (21).

In addition to the subjective feeling of nasal obstruction (SNO), which is known to have a negative impact on HRQOL (22, 23), patients with septum deviation may also suffer from nasal discharge, crusting, sneezing, epistaxis, snoring, oral breathing, and recurrent sinus infections (24).

The diagnose is usually based on the patient's symptoms, anterior rhinoscopy, and nasal endoscopy and may be supplemented by physical measures from tests such as AR, rhinomanometry and PNIF(1).

2.2.2 Inferior turbinate hypertrophy

Inferior turbinate hypertrophy (ITH) is a condition in which the turbinate tissue becomes inflamed as a result of allergic and non-allergic rhinitis, other environmental triggers such as dust and tobacco, and medical causes, including pregnancy and sometimes as a compensatory response to an evident septal deformity (9, 25, 26).

ITH affects 10-20 percent of Europe`s adult population (9, 27). Patients with ITH report a variety of symptoms such as SNO, nasal discharge, disturbed sleep, tiredness, and poor concentration, which can affect school and work (28). Although it is not a life-threatening condition, it can cause a significant decrease in HRQOL by dehydration of the upper and lower airways caused by the passage of cold or hot dry air through the mouth (28, 29). Patients may enter a vicious circle by treating

themselves with decongestive nasal spray over a long period, leading to habituation and drying of the nasal mucosa (30).

The diagnosis of ITH is made by patients' symptoms and clinical examination, including anterior rhinoscopy and nasal endoscopy, often conducted before and after topical decongestion (31). AR, rhinomanometry and PNIF can also be applied in diagnosing ITH. The patient's history is crucial to identify the underlying cause of the inflammation, including allergy testing.

2.2.3 Chronic rhinosinusitis

Chronic rhinosinusitis (CRS) is a clinical syndrome characterized by mucosal inflammation of the nose and paranasal sinuses, causing mucosal edema, growth of NP, and secretion (32, 33). CRS affects 5-15 percent of the general population (34, 35). In Europe, the prevalence is 10.9 percent (33), estimated after the criteria in the "European Position Paper on Rhinosinusitis and Nasal Polyps 2012" (EPOS) (36).

The EPOS criteria for diagnosing CRS with and without NP in adults are:

> *inflammation of the nose and the paranasal sinuses characterized by two or more symptoms for ≥ 12 weeks, one of which should be either nasal obstruction or nasal discharge: ± facial pain/pressure or ± reduction or loss of smell(36).*

This should be supported by demonstrable disease by either endoscopic signs (NP, mucopurulent discharge, edema) and/or CT changes (mucosal changes)(36).

CRS is broadly divided into two subgroups: CRS with and without NP (CRSwNP, CRSsNP) based on endoscopic findings. In general, NP occur in all races, become more common with age, and more frequent in men than women (37). Ciliary

impairment, allergy, asthma, and aspirin sensitivity are some of the many factors associated with CRSwNP and CRSsNP (33, 36).

SNO is the most frequently reported symptom in CRS, but also nasal discharge, anosmia, facial pain, ear pain or pressure, dizziness, headache, dental pain, somnolence, and impaired daytime functioning are common complaints from patients suffering from CRS (32, 38-40). In patients suffering from CRS, the symptom severity on VAS is considered mild between 0 and 30, moderate from 30 to 70, and severe from 70 to 100(36) .

Studies have shown that patients with CRSwNP and CRSsNP may differ in symptom severity. CRSwNP patients tend to report more SNO and loss of smell compared to CRSsNP, who report more facial pain and headache (41). CRS primarily affects patients' HRQOL and is an important reason for absenteeism from work (42). CRS is shown to have a greater impact on HRQOL in some aspects than other chronic diseases such as angina and chronic obstructive pulmonary disease (43).

Assessment of severity and duration of the patient's symptoms and HRQOL, physical examination including nasal endoscopy, bacteriology, and occasionally CT and MRI are important tools in diagnosing and selecting the optimal treatment for CRS with or without NP (44). Additional assessment may be performed related to, for example, ciliary and olfactory function, nitric oxide, and measures of nasal resistance, geometry, and airflow.

Nasal endoscopy and CT improves diagnostic accuracy for CRS. Nasal endoscopy is recommended as a diagnostic tool early in the clinical evaluation to reduce cost and radiation exposure from CT scanning (45). However, CT is important to exclude

differential diagnosis (36) and to improve diagnostic accuracy, especially after failed medical treatment where surgery is the next alternative. A study has shown that approximately 50 percent of symptom positive patients (diagnostic criteria broadly in line with the EPOS criteria) had no positive changes on CT (45).

As mentioned before, the classification of CRS-patients has been based on clinical symptoms, atopy status, and the presence of nasal polyps. Recently, classification based on the underlying inflammatory mechanisms has gained more interest (46). In Western countries, eosinophilic inflammation is associated with CRSwNP, while neutrophilic inflammation is associated with CRSsNP (47, 48).

2.3 Medical treatment

Treatment of the conditions mentioned is fundamentally pharmacological (topical and/or systemic) when the etiology is inflammatory or functional.

Septum deviation: If the deviation is moderate and involves more of the cartilaginous regions with additional hypertrophy of ITH, initial treatment may be saline irrigation, nasal steroid spray, short-term use of decongestants and antihistamine medication, which aims to manage the symptoms of the tissues lining in the nose. If medical treatment fails, surgical repositioning may be necessary.

ITH: The initial treatment is mainly antihistamines, topical decongestants, and corticosteroids. These medications provide symptomatic relief but no permanent cure. Therefore, it is crucial to identify and, if possible, eliminate the cause of the hypertrophy, which in many cases is due to allergy. When optimal medical management has been unsatisfactory in the relief of nasal obstruction, surgical intervention is warranted (25, 49).

CRSwNP: Topical corticosteroids are the medical treatment of choice (50). If the polyps are resistant to topical treatment, systemic steroids can reduce polyp size and facilitate the use of nasal steroids. It is important to continue the use of topical steroids after courses with systemic steroids to inhibit the regrowth of polyps. Antibiotics may be indicated if CRSwNP is complicated by infection (51).

CRSsNP: Topical and systemic corticosteroids and antibiotics are recommended as the preferred treatment, which aims to reduce mucosal inflammation and eliminate infection by improving ventilation and drainage from the sinuses (36, 51). Also, decongestants for a short period and saline irrigation may be recommended.

In both CRSwNP and CRSsNP, antihistamines and antileukotrienes may be considered in allergic patients with asthma.

CT and endoscopic surgery may be necessary if medical treatment fails to complement or improve medical treatment, or when other therapeutic approaches are not possible. Combinations of surgical techniques and medical treatment may be necessary (36, 52).

2.4 Surgical treatment

2.4.1 Septoplasty

Septoplasty is a surgical procedure designed to correct a deviated septum to improve nasal function, form, or both (53) and is the most frequently performed ENT- surgery in adults (Figure 4)(54). It may be performed alone or in combination with a reduction of the ITH (22). The main indication for septoplasty is SNO (55). Septoplasty can also be used as an adjunctive procedure to improve access to and the function of the paranasal sinuses (53). Septoplasty can be performed in local or

general anesthesia, and several techniques exist. Potential complications after septoplasty are hemorrhage, septal perforation, adhesions, and infections, among others (56).

Temporary nasal plates and packing are often inserted perioperative to support and prevent bleeding and adhesions postoperatively. Sick leave for 1-2 weeks is common after septoplasty (57). The effectiveness of septoplasty has been questioned, and contradictory results have been reported (24, 58, 59).

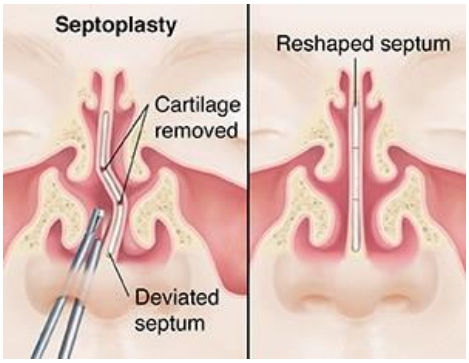

Figure 3. Septoplasty (The StayWell Company)

2.4.2 Reduction of inferior turbinate hypertrophy

Turbinate surgery is commonly practiced as a treatment to relieve SNO, generally involving reducing the size of the inferior turbinate (60). The goal of surgical therapy is to maximize the nasal airway, preserve nasal mucosal function, and minimize complications.

In 1882, Jarvis first reported inferior turbinate surgery (61). Since then, numerous ITH reduction techniques have been employed (9, 22), but turbinate surgery has frequently been driven by new technology rather than patients' benefits (62). ITH reduction has typically low complication rates; occasionally bleeding and crusting

can occur (60). However, ITH reduction has been the subject of an ongoing disagreement over its effectiveness and long-term benefit (9).

Radiofrequency therapy for inferior turbinate (RFIT), also known as radiofrequency volumetric tissue reduction, is a frequently used procedure causing submucosal thermal lesions, which reduces the size of the inferior turbinate (27). The device, an electrode probe, heats the turbinate tissue with little heat dissipation, sparing damage to adjacent structures or mucosal surfaces (Figure 4). The procedure can be performed under local anesthesia in an outpatient setting. The use of nasal packing is generally unnecessary, and the patients normally can return to work or school within a short time. Studies have shown that RFIT has a positive effect on nasal obstruction, but efficacy may diminish over time (25).

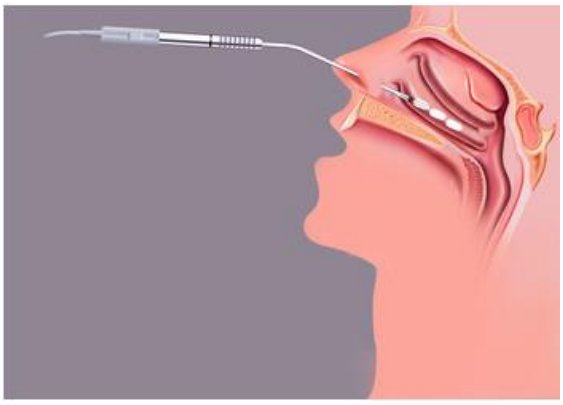

Figure 4. RFIT of inferior turbinate (Sutter Medizintechnik)

2.4.3 Functional Endoscopic Sinus surgery (FESS)

FESS describes an approach and not a standardized operation (36). FESS involves the clearance of polyps and polypoid mucosa and opening of the sinus ostia to improve ventilation and drainage between the sinuses and nasal cavity. FESS is also utilized to improve the distribution of topical steroids to the sinuses.

Over the last 30 years, the field of sinus surgery has advanced from open surgical procedures, associated with significant morbidity, to functional endoscopic procedures using state-of-the-art instrumentation, high definition cameras, and intraoperative surgical navigation (63).

The extent of surgery may vary from uncinectomy to radical sphenoethmoidectomy (36), and the duration of the surgery varies immensely according to the extent of disease. FESS is usually performed in general anesthesia, although the less extensive procedure such as, for example, ethmoidectomy, is occasionally performed in local anesthesia.

Postoperatively, the patients usually have a temporary nasal packing in the middle meatus to prevent bleeding and adhesions (64). Blood seeping from the nose the first 3-4 days, nasal congestion due to surgical trauma and crusts, and mild to moderate nasal pain and headache are events that are considered to be normal phenomena occurring after FESS (51).

It is recommended that the patients rinse their nose several times daily with saline irrigation. Also, endoscopic debridement should be performed by the surgeon 10-12 days postoperatively to remove crusts and secretions (65) and to open the nose for treatment with local steroids (66). Usually, the patients are advised to take two weeks of sick leave.

Severe and major complications during and after FESS occur in approximately 1 percent of the cases (67). Complications during surgery can be bleeding, penetration of the skull base, or penetration of the orbit. Bleeding and postoperative infections may appear after surgery (51, 67). Several studies have reported positive results in medically refractory CRS patients undergoing FESS (44, 68-70).

3 Quality of life (QOL)

The patient’s subjective assessment of elements of their health, such as health-related quality of life and symptoms, belongs to the broader term patient reported outcome measures (PROMs)(71, 72). PROMs are defined as: *“any report of the status of a patient’s health condition that comes directly from the patient, without interpretation of the patient’s response by a clinician or anyone else”* (70).

3.1 The concept of QOL

The term QOL was introduced in the medical literature in the 1960s, and from 1975, QOL became a keyword in medical literature databases (73). There are numerous definitions of QOL, and no single and universally accepted definition exists(74). WHO defines QOL as: “*an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns” (75)*.

QOL is a wide-ranging concept affected in a complex way by the person's physical health, psychological state, personal beliefs, social relationships, and their relationship to their environment (75) .

QOL can be viewed on many levels; a three-level approach is a generally accepted basis approach (74, 76). The overall assessment of quality of life is on the top level and may be described as an individual’s overall satisfaction with life and one’s general sense of well-being, also referred to as global quality of life (74).

The middle level consists of several broader domains that describe the generic perspective of QOL related to health (72, 74, 76). The lowest level includes all the

components of each domain that are disease-specific, usually used to measure function and levels of disease severity (72, 74, 76) (Figure 5).

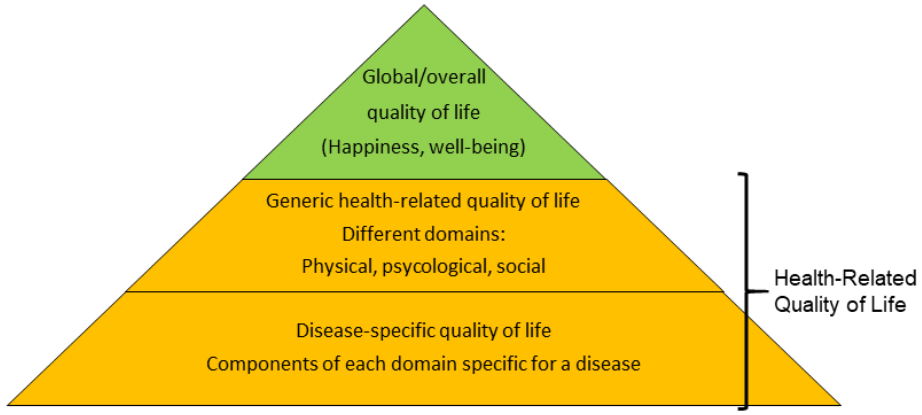

Figure 5: Three levels of quality of life

3.2 Health-related quality of life (HRQOL)

In the mid-1980s, the term HRQOL appeared for the first time (73). HRQOL is closely related to the World Health Organization`s definition of health as *"a complete state of physical, mental, and social well-being, not merely the absence of disease"* (1948).

The concept of HRQOL was, therefore, developed to capture aspects of an individual`s subjective experience related to health, disease, disability and impairment, and the effects of medical treatment (77, 78). Various definitions of HRQOL exist. HRQOL is often defined from a functionalist perspective on society, which relates to the ability to perform activities of daily living and fulfill role obligations (79). Spilker defines HRQOL "as the functional effect of a medical condition and/or its consequent therapy upon a patient, as perceived by the patient" (74). HRQOL is a subjective and multidimensional concept encompassing physical

and occupational function, psychological state, social interaction, and somatic sensation (74, 80).

The physical and occupational function is the QOL factor that most nearly approximates the outcome measures physicians traditionally use. Questions about strength, energy, and the ability to carry on normal activities are typically asked.

Psychological function covers a wide range of distinct emotional states (e.g., depression, anxiety, happiness). The psychometric measures may be simple questions inquiring about mood, anxiety, or depression.

Social interaction refers to a patient's ability to carry on person-to-person interactions. These interactions are often thought of as family, close friends, work, vocational associates, and general society.

Somatic sensation, symptoms, encompasses unpleasant physical feelings. They include pain, nausea, and shortness of breath, among others (74).

These four domains do not represent the total spectrum of HRQOL, but they appear to encompass a large proportion of the everyday concerns of people (74).

HRQOL, as an outcome measure, broadens outcome toward considering the impact of the condition and its treatment on the person's emotional, physical, and social functioning. It addresses the question of whether the treatment leads, in its most extreme, to a life worth living, and it provides a more subjective, patient-led baseline against which the effects of interventions can be evaluated (72).

HRQOL has become a relevant measure of efficacy in clinical research as a supplement to biochemical markers and survival rates and can give information about whether a treatment is beneficial (74, 81). HRQOL studies can help to improve the quality of the patient's treatment and outcomes, to differentiate between

two therapies with marginal differences in mortality/morbidity, and to compare outcomes between different treatment modalities such as medicine versus surgery. HRQOL data may also estimate the burden of specific diseases on function and well-being (74).

Evaluating the impact of diseases on HRQOL can be performed using both disease-specific and generic measures. It can do this only if the measurement scale reflecting its components is valid, reliable, sensitive, and responsive to change (72). Validity refers to whether an instrument measures what it is intended to measure (79). Face validity referes to whether an instrument *appears* to be measuring what it is intended to measure (74). Content validity is the extent to which the scale taps all relevant concepts of the attribute to be measured. Reliability refers to the measurement's ability to produce similar results on the same respondent under consistent conditions at different times (79). Sensitivity is the extent to which a measurement can detect changes between patients or groups of patients (76). Responsiveness is similar to sensitivity but focusses on the measurement's ability to detect changes when a person is getting better or worse and is of great importance to detect clinically important changes.

3.2.1 Generic instruments

A generic instrument attempts to measure all important aspects of HRQOL and deals with a wide variety of areas and can be used in any population, irrespective of the underlying condition (74). The term generic or general measures implies they assess health concepts that represent basic human values that are relevant to everyone's functional status and well-being, regardless of age, disease, or treatment

group (82). They should encompass dimensions of physical, mental, and social health and permit comparison between different diseases and conditions (74, 79). A generic instrument can provide complementary information about the range and treatment effects on HRQOL, and previously unrecognized adverse experiences can be detected (74). Generic instruments frequently used for rhinologic patients are the EuroQol five-dimensional questionnaire (EQ-5D)(83, 84) and the Short Form Health Survey 36 (SF-36)(85).

SF-36 measures eight domains, or aspects, of health status that are considered important for describing and monitoring individuals suffering from a disease or illness: physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional (RE), general mental health (MH). The eight domain scales can be gathered into two summary scales, physical and mental health (86). SF-36 is a valid instrument, translated into Norwegian, that can be used to compare generic HRQOL profiles for groups differing in diagnosis, disease severity, or treatment regimen and monitor transitions in health status over time (87).

3.2.2 Disease-specific instruments

Disease-specific instruments or scales are used to identify condition-specific aspects of a disease (76, 79). Disease-specific scales may contribute to ensuring sensitivity to sometimes small, but clinically significant, changes in levels of disease severity (e.g., symptoms)(79, 88). If the patient has multiple health problems, it is recommended to combine it with a generic measure (72).

Frequently used disease-specific instruments in rhinology are the Sino-Nasal Outcome Tests with the modified versions SNOT-16, SNOT-20, SNOT- 22, SNOT-

23 (89), and SNOT-25 (90), consisting of several nasal, sinus, and general items to determine the disease-specific HRQOL (91, 92).

SNOT-20 is validated in the English language (91) and was translated to Norwegian by Steinsvåg and Kjærgaard. It is used in several Norwegian studies (93-96) and is deemed to have acceptable face validity. The questionnaire can be divided into four subsets; the first subset consists of questions related to nose issues; the second subset is related to the ear and face issues; the third subset is related to sleep quality, and the fourth subset is related to psychological issues (97).

3.2.3 Symptoms

Symptoms and the restrictions they may impose on everyday life and activities are, as mentioned above, often incorporated in disease-specific HRQOL instruments. In addition, patients' symptom severity is often quantifyed by using visual analog scales (VAS). VAS scales have shown satisfactory properties regarding reproducibility and sensitivity to change (98). Symptom measures on VAS have proven to be significantly correlated to validated instruments like the Rhinoconjunctivitis Quality of Life Questionnaire (RQLQ)(99).

3.2.4 Minimal important difference (MID)

If a study results in statistical changes in HRQOL outcomes, the key question is the extent to which these results are clinically meaningful for the patient. Due to this, the concept of "minimal clinically important difference" (MCID) was developed. MCID is defined as "*the smallest important difference in score in the domain of interest that patients perceive as beneficial and which would cause clinicians to consider a change in the patient's management*" (100). The term was shortened to minimally

important difference (MID) in the context of patient-reported outcomes to emphasize the perspective of the patient and not be limited to clinical evidence (101).

There are several approaches to define MID in symptoms and HRQOL outcomes such as; for example, 10 points on a 0–100 point scale (100) or a ½ SD of the mean baseline score (102). Some instruments suggest specific methods to calculate MID, while others have established MID values based on specific diseases. It is important to underscore that no approach is perfect because of the subjective and qualitative nature of symptoms and HRQOL (100), a MID on group level may be different from a MID for individual respondent scores and the MID in one disease is not neccesarily equal to the MID in a different disease (103).

For the purpose of this thesis the minimal mean group difference (improvement) is referred to as MID.

4 Physical measurements of nasal patency

The perception of nasal airflow is primarily a subjective sensation but is related to the anatomy and physiology of the nasal passages (104). Methods that measure nasal geometry and nasal airflow can be used to assess nasal patency and to evaluate the outcome of treatment (1, 4).

Acoustic Rhinometry (AR) is a simple, noninvasive way to measure nasal patency as it provides a static view of the geometry in the anterior section of the nasal cavity. AR uses a sonic echo technique where an acoustic wave is transmitted into the nostril through a tube. The reflected sound signals are used to create a plot of the minimal cross-sectional areas (MCA) as a function of the distance from the nasal

orifice. Nasal cavity volumes (NCV) are calculated from the cross-sectional values (8, 21, 105).

The test is highly reproducible and can give information about the site of the obstruction (8, 10, 106). AR can be performed with and without decongesting of the mucosa. In an ideal setting, AR should be performed before and after decongestion in order to determine whether the cause of the obstruction is mucosal or skeletal, as well as to minimize the interference of the nasal cycle.

Peak nasal inspiratory flow (PNIF) is a noninvasive and easy to perform method to assess nasal patency. It is a reproducible and validated physiological measure of nasal airflow obtained during maximal forced inspiration and indicates the peak nasal airflow in liters per minute (l/min)(107, 108).

5 Medical Quality Register

Several developments in healthcare, such as progress in information technology and increasing demands for accountability, have led to an increase in the number of medical registries over recent years (109). In Norway, more than 50 national medical quality registries exist, in addition to several local medical registries (110).

A registry is defined as *"a data base of identifiable persons containing a clearly defined set of health and demographic data collected for a specific public health purpose*" (111).

Their purpose is to contribute to a better quality of care and establish and monitor clinical guidelines to reduce variation in care and quality of treatment. Registers may also serve as a resource for research by providing comprehensive data on the patient groups of interest (112). The register data must be of high quality to be

useful, and two frequently cited data quality attributes are completeness and correctness (109).

The quality register at the Ear, Nose, and Throat (ENT) Department at St. Olav's hospital was approved by the Data Protection Officer (Personvernombudet) at St. Olav's hospital in January 2012. The consent-based register consists of data from patients ≥ 18 years of age with a variety of conditions that require surgery in the nose and sinuses, mainly of patients receiving surgery due to septal deviation, ITH, and CRS with and without nasal polyps. Few patients refuse to participate in the register; consequently, the main proportion of patients who are not included in the register are patients with a long traveling distance or difficulty in answering the questionnaires. The inclusion rate based on patients referred to surgery from the outpatient clinic is approximately 200 patients per year.

6 Review of a selection of studies

There has been a growing interest and use of HRQOL outcomes in rhinologic research during the last decades. Numerous studies have investigated outcomes in patients receiving surgical treatment due to septum deviation, ITH, or CRSwNP and CRSsNP. However, the studies vary in design, patient selection, sample size, and which outcome is being measured.

Initially in this work, a systematic literature search was performed, mainly in PubMed, with assistance from NTNU`s university library. Repeated searches were performed during the study period. We did not find studies that examine and compare SNOT-20- and SF-36 measures in the three patient groups concurrently undergoing septoplasty only, septoplasty combined with RFIT, and RFIT only. Most studies have compared outcomes from septoplasty and septoplasty combined with

a reduction of ITH. Although reduction of ITH in combination with septoplasty is a relatively common clinical procedure, the effectiveness and the indications and technique applied vary widely (113). More research comparing techniques and assessing outcomes on surgical treatment of ITH is needed (60). There is also a lack of studies that differentiate between CRS patients with and without nasal polyps undergoing sinus surgery that examines both disease-specific and generic HRQOL. A Cochrane review from 2014 on surgical versus medical interventions for CRSwNP stated that the overall evidence is of very low quality and insufficient to draw firm conclusions, thus further research is justified as this problem has significant implications for HRQOL and healthcare service usage (114).

A selection of studies on symptoms, HRQOL, and physical measures from septoplasty, inferior turbinate surgery, and sinus surgery are listed below.

6.1 Table 1: Papers on outcomes of septoplasty and inferior turbinate surgery

Author (ref.) Year	Title	n	Measures Follow-up time	Intervention
Achevedo et al.(115) **2015, Review**	*Radiofrequency Ablation Turbinoplasty versus Microdebrider-Assisted Turbinoplasty*	26 studies	VAS SNO, RMM 6 months	RFIT vs Microdebrider-turbinoplasty
Akduman et al.(116) **2013**	*Patients evaluation for the surgical management of nasal obstruction*	134	Glasgow Benefit Inventory GBI NOSE scale Likert scale SNO	Septoplasty vs septoplasty+ITHR vs septoplasty+valve surgery
Karlsson et al.(117) **2012**	*Septoplasty with concomitant inferior turbinate reduction reduces the need for revision procedure*	2168	Demographics, technique of primary surgery, grade of surgeon	Septoplasty vs Septoplasty+ ITHR
Hytönen et al.(24) **2011**	*Does septoplasty enhance the quality of life in patients?*	126	15D (generic), SNOT-22 6 months	Septoplasty
Baumann (22) **2010, Review**	*Quality of life before and after septoplasty and rhinoplasty*		A variety of disease-specific and generic measures	Septoplasty and rhinoplasty
Deversen et al.(118) **2010**	*A RTC: Outcome of submucous resection of compensatory IT during septoplasty*	42	VAS SNO, AR, RMM 1, 3, 6 months	Septoplasty with ITHR vs septoplasty only
Croy et al.(58) **2010**	*Quality of life following nasal surgery*	361	SF-36, RSDI 4,2 months	Septum surgery vs sinus surgery
Batra et al.(49) **2009, Review**	*Surgical management of adult inferior turbinate hypertrophy: A systematic review*	96 studies	Subjective and objective measures 6 - 18 months	ITH surgery

Harrill et al.(119) 2007	*Radiofrequency Turbinate Reduction: A nose evaluation*	67	NOSE scale 3 and 6 months	Septoplasty + RFIT vs RFIT only
Schwentner et al.(120) 2006	*Does nasal septal surgery improve quality of life?*	285	Combining generic, disease-specific HRQOL, symptoms, last 7 years	Septal surgery with or without ITR
Stewart et al.(121) 2004	*Outcomes after nasal septoplasty: results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study*	59	NOSE scale, Likert scale SNO 3 and 6 months	Septoplasty with ITHR
Seeger et al.(27) 2003	*Bipolar radiofrequency-induced thermotherapy of turbinate hypertrophy*	38	SNO: VAS 20 months	RFIT with Celon
Arunachalam et al.(122) 2001	*Nasal septal surgery: evaluation of symptomatic and general health outcomes*	121	Fairley nasal symptom score, Nottingham health profile, General Health GHQ28, 6 weeks	Septoplasty
Coste et al.(123) 2001	*Radiofrequency is safe and effective treatment of turbinate hypertrophy*	14	SNO VAS, AR 3 months	RFIT
Siegel et al.(124) 2000	*Outcomes of septoplasty*	93	Nasal specific health-quest., General health survey SF-12, 9 months	Septoplasty with additional nasal surgery
Pirilä et al.(125) 2001	*Unilateral and bilateral effects of nasal septal surgery demonstrated with acoustic rhinometry, rhinomanometry, and subjective assessment.*	117	AR, RMM, SNO Likert scale, Satisfaction 12 months	Septoplasty only
Illum(113) 1997	*Septoplasty and compensatory inferior turbinate hypertrophy: long-term results after randomized turbinoplasty*	50	AR, SNO Satisfaction, 5 years	Septoplasty vs septoplasty with ITHR

AR: Acoustic rhinometry; SNO: Subjective nasal obstruction; VAS: Visual analog scale; RMM: Rhinomanometry; vs: versus; RFIT: Radiofrequency therapy of inferior turbinate; ITHR: Inferior turbinate reduction; RSDI: Rhinosinusitis disability index

6.2 Table 2: Papers on outcomes after sinus surgery

Author (ref.) Year	Title	n	Measures Follow-up time	Intervention Subjects
Sahlstrand-Johnson et al.(42) **2017**	*The effect of ESS on quality of life and absenteeism in patients with chronic rhinosinusitis- a multi-center study*	181	VAS, SNOT-22 SF-36 6, 12 months	FESS (CRSwNP, CRSsNP)
Andrews et al.(70) **2016**	*Outcomes in sinus surgery: Olfaction, nose scale and quality of life in a prospective cohort study*	113	Olfaction VAS, NOSE, SNOT-22 6 months	FESS (CRSwNP, CRSsNP)
Djukic et al.(68) **2015**	*Clinical outcomes and quality of life in patients with nasal polyposis after functional endoscopic sinus surgery*	85	VAS symptoms, SF-36, CT, endoscopy 6, 12 months	FESS (CRSwNP)
Hopkins et al.(126) **2015**	*The predictive value of the preoperative SNOT-22 score in patients undergoing ESS*	2263	SNOT-22 3, 12 months	FESS (CRSwNP, CRSsNP)
Rimmer et al.(114) **2014, Review**	*Surgical versus medical interventions for chronic rhinosinusitis with nasal polyps*	231	VAS symptoms, SNOT-20, SF-36 (4 studies)	Surgery vs medical treatment, (CRSwNP)
Katotomichelakis et al.(127) 2013	*Predictors of QOL outcomes in CRS after sinus surgery*	159	Olfaction-specific questionnaire SF-36 (one value),12 months	ESS (CRS vs controls)
Kennedy et al.(128) **2013**	*SNOT 22: a predictor of postsurgical improvement in patients with CRS*	104	SNOT-22 3- 6 months follow up	FESS (CRS)
Sahlstrand-Johnson et al.(38) **2011**	*A multi-center study on quality of life and absenteeism in patients with CRS referred for endoscopic surgery*	180	SNOT-22 SF-36 HADs	CRS patients awaiting sinus surgery

Ragab et al.(44) 2010	*Impact of chronic rhinosinusitis therapy on quality of life: a prospective randomized controlled trial*	90	SNOT-20 SF-36 6, 12 months	Surgery vs medical treatment (CRSwNP, CRSsNP)
Smith et al.(129) 2010	*Determinants of outcomes of sinus surgery: a multi-institutional prospective cohort study*	302	RDI, CSS, SF-36 17 months follow up	ESS (CRS)
Hopkins et al.(130) 2009	*Long-term outcomes from the English national comparative audit of surgery for nasal polyposis and chronic rhinosinusitis*	1459	SNOT-22	Sinonasal surgery (CRSwNP, CRSsNP)
Deal et al.(131) 2004	*Significance of nasal polyps in Chronic Rhinosinusitis: Symptoms and Surgical outcomes*	201	SNOT-20, CT 6, 12 months	FESS (CRSwNP, CRSsNP)
Bugten et al.(41) 2008	*Chronic rhinosinusitis and nasal polyposis; indicia of heterogeneity*	102	VAS symptoms Satisfaction	FESS (CRSsNP, CRSwNP)
Chester et al.(132) 2008, Review	*Systematic review of change in bodily pain after sinus surgery (*1980-2008)	1019	SF-36 BP, SF-8 6 months	FESS (CRS)
Lee et al. 2008	*Comparison of the surgical outcome between primary and revision endoscopic sinus surgery for CRS with nasal polyps*	125	SNOT-20 Endoscopy scores 6,12 months	FESS (CRSwNP)
Reh et al.(133) 2007	*Impact of age on presentation of CRS and outcomes of ESS*	139	VAS, RSDI, CSS, Mean follow-up time 19 months	ESS (CRS)
Smith et al.(134) 2005	*Predictive factors and outcomes in endoscopic sinus surgery for CRS*	119	RSDI, CSS, CT, endoscopy Mean follow up 1,4 years	FESS (CRSsNP, CRSwNP)

FESS: Functional endoscopic sinus surgery; CRSwNP: Chronic rhinosinusitis with nasal polyps, CRSsNP: Chronic rhinosinusitis without nasal polyps; VAS: Visual analog scale, SNOT-20: Sino nasal outcome test; SF-36: Short form health survey; ESS: Endoscopic sinus surgery; RSDI: Rhinosinusitis Disability Index, CSS: Chronic Sinusitis survey

7 Aims of study

In regard of the limited amount of studies that examine subjective and physical outcomes in patients undergoing septoplasty, septoplasty combined with RFIT and RFIT only, and studies that examine disease specific and generic HRQOL in CRS patients based on the presence of NP or not, we intended—with the use of register data from our clinical daily practice—to answer the following aims:

7.1 Overall aim

The primary aim is to examine symptoms and HRQOL before and after surgery in patients undergoing surgery for septum deviation, ITH, CRSwNP, or CRSsNP. Nasal areas and volumes and airflow is also examined in patients with septum deviation and ITH. A secondary aim is to compare the improvement in the outcomes among the groups. Finally, the association between patient factors and HRQOL improvement after surgery is investigated in the CRS groups.

7.2 Research questions paper 1

Does surgical treatment improve symptoms and HRQOL in patients who undergo septoplasty alone, septoplasty in combination with RFIT, or RFIT alone?

Does the change in outcomes after surgery differ among the groups?

7.3 Research questions paper 2

Does surgical treatment improve the MCA, NCV and PNIF in patients who undergo septoplasty alone, septoplasty in combination with RFIT, or RFIT alone?

Does the improvement in outcomes differ among the groups?

Is there a significant correlation between measures of MCA, NCV or PNIF and SNO?

7.4 Research questions paper 3

Does surgical treatment improve symptoms and disease-specific and generic HRQOL in patients with CRSwNP and CRSsNP who undergo functional endoscopic sinus surgery? Does the change in outcomes differ among the groups?

Which patient factors are associated with HRQOL outcome after surgery?

8 Materials and methods

8.1 Design and study population

The data used in the prospective observational registry studies in this thesis derive from patients included in the local “Nose and sinus surgery” quality register at the ENT department at St. Olav’s hospital in the period from January 2012 to October 2017.

All patients were referred from general practitioners, private otorhinolaryngologists, or local hospitals in the region to assessment for surgical treatment at the ENT department of St. Olav’s hospital and examined at the outpatient clinic by a variety of surgeons. When there was an indication for septoplasty, septoplasty combined with RFIT, RFIT, or functional endoscopic sinus surgery, the patients were asked to participate in the register. All patients included gave a informed written consent to participation in the registry and consented to the use of their data in rhinologic research. The studies in this thesis were approved by the regional committees of medical and health ethics (REK 2015/367).

8.2 Data management

All data were collected on questionnaires that were scanned into an electronic database. Correctness and completeness of data were reviewed by a senior engineer and the research nurse. Eligible patients who had undergone surgery were identified according to diagnosis codes. To secure correct patient selection in case of erroneous coding, the main supervisor and the research nurse controlled the register data with the patient's medical journal. The patients were then included in the studies according to the inclusion and exclusion criteria.

8.3 Papers 1 and 2 Diagnose, inclusion and exclusion criteria

The diagnoses were based on anterior rhinoscopy and nasal endoscopy combined with patients' symptoms.

Inclusion criteria: a deviated nasal septum or a deviated nasal septum in combination with ITH, or ITH without clinically significant septum deviation, with presenting symptoms of chronic nasal obstruction lasting at least three months and still persistent after medical management that were referred for surgery.

Exclusion criteria: age less than 18 years, difficulty in interpreting the questionnaires due to language or cognitive problems, pregnancy, ongoing cancer treatment, granulomatosis with polyangiitis, cystic fibrosis, Kartagener syndrome, and sarcoidosis or ciliary dyskinesia.

In studies 1 and 2, the study population consisted originally of the same 210 patients.

Study 1: Due to dropouts before surgery, loss to follow-up, missing pre- or post-operative data, and exclusion because of comorbidity, the total sample was 171(81%) patients: 57 patients undergoing septoplasty, 56 patients undergoing septoplasty combined with RFIT, and 58 patients undergoing RFIT only (Figure 3). Of the patients who underwent surgery, this represents a follow-up rate in each patients group of 95 percent, 93 percent, and 83 percent, respectively.

Study 2: Due to the use of two similar PNIF instruments with different maximum flow registration of, respectively; 120 l/min in the period 01.01.2012–18.06.2013 and 370 l/min in the period 19.06.2013–31.12.2015, 23 patients from the first period with an accurate score of 120 l/min were excluded from the analyses. The total sample was 148 (71%) patients: 50 patients in the septoplasty group, 51 patients in the septoplasty combined with RFIT group, and 47 patients in the RFIT group (Figure 6). This represents a total follow-up rate after surgery in each group of 83 percent, 85 percent, and 67 percent, respectively.

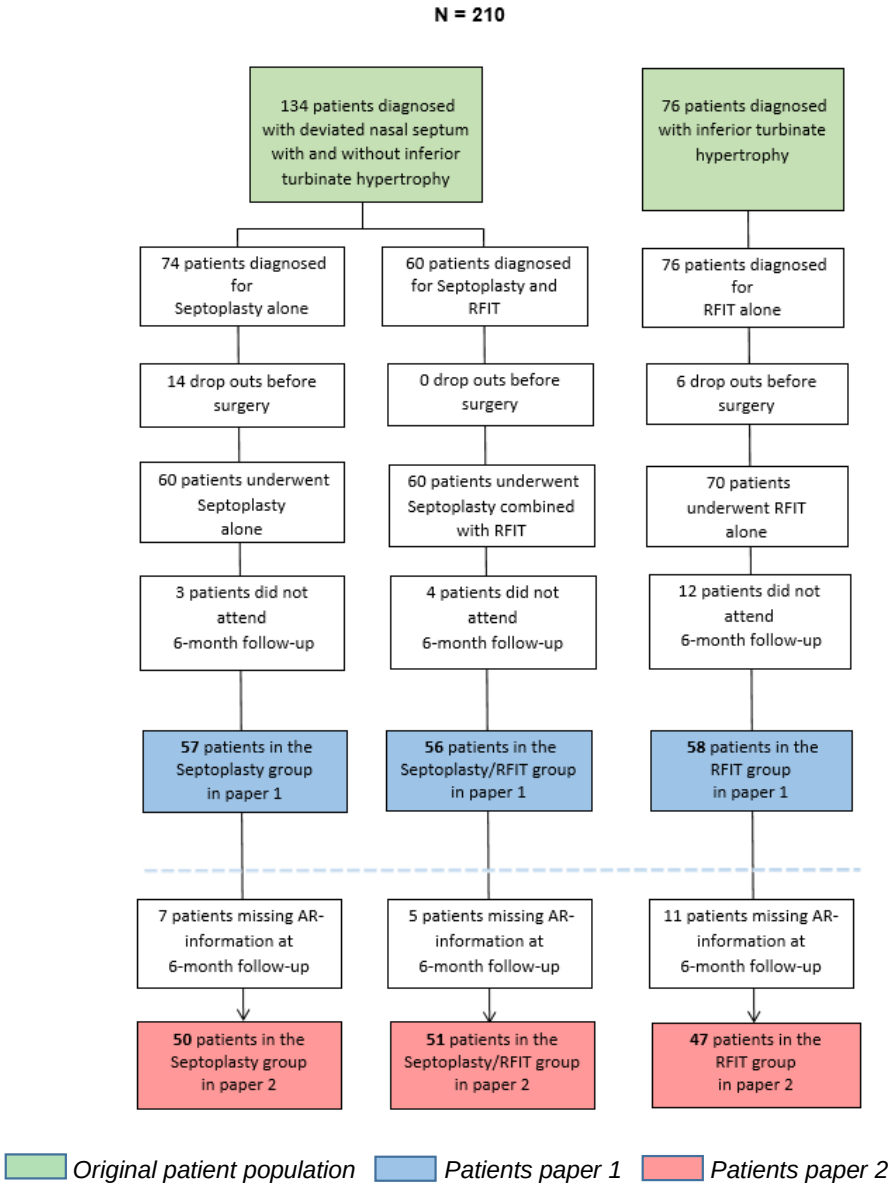

Figure 6: Flow chart patients paper 1 and 2

8.4 Paper 3: Diagnose, inclusion and exclusion criteria

The diagnosis was based on the patient's symptoms, endoscopic evaluation, and CT scanning of the sinuses in accordance with the EPOS criteria.

Inclusion criteria: a diagnosis of CRS, where all patients have had treatment with antibiotics combined with corticosteroids for 10 to 14 days, followed by topical corticosteroids for at least 12 weeks before they were referred for surgery.

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

Originally, the study population consisted of 469 patients. Due to dropouts before surgery, loss to follow-up, missing pre- or postoperative data, and exclusion because of comorbidity, the total sample was 416 patients: 220 CRSwNP and 196 CRSsNP patients (Figure 7). This represents a total follow-up rate after surgery of 89 percent.

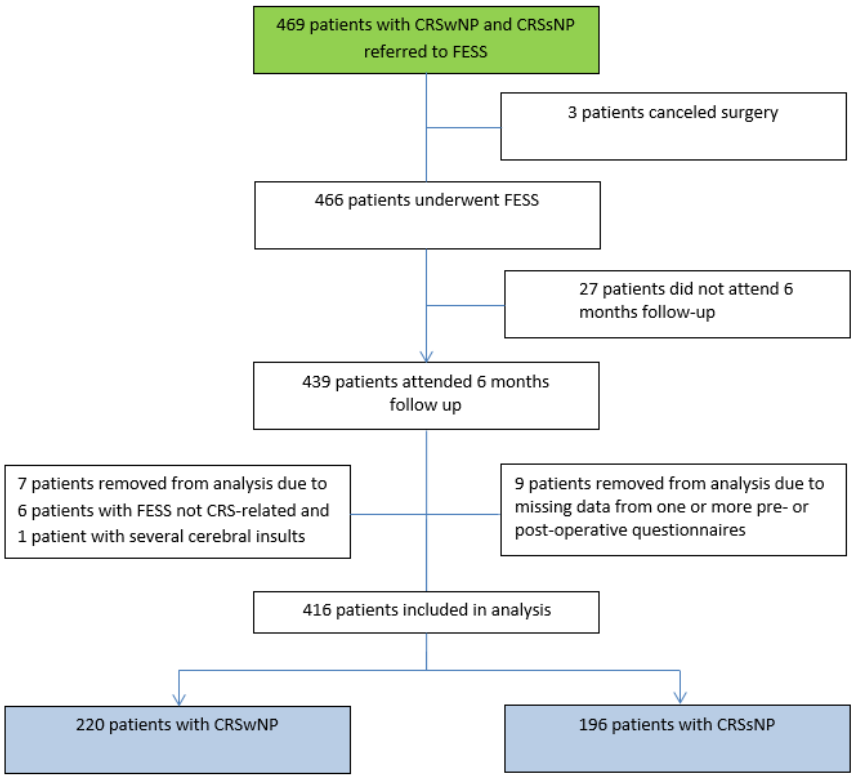

Figure 7: Flow chart patients paper 3

8.5 Measures/Recordings

Data such as symptoms, HRQOL, nasal area, volume, and airflow were collected before and six months after surgery. Data regarding demographics, medical history, symptoms, and HRQOL were self-reported by the patients, while specially trained nurses performed the physical tests, and a variety of doctors performed the clinical assessment and the surgery of the patients.

All questionnaires used in this thesis are presented in the appendix.

8.5.1 VAS

The degree of nasal obstruction, nasal discharge, sneezing, oral breathing, snoring, altered sense of smell, facial pain, sinus pressure, and affected general health was assessed by the patient on a 100 mm visual analog scale (VAS) based on the previous two weeks. The endpoints where 0 mm (no complaints) and 100 mm (complaints as severe as can be). An improvement in SNO of 30 mm on a 100 mm scale or more can be considered a MID (3).

8.5.2 SNOT-20

The patients were asked to grade 20 items on a scale from 0 (no problem) to 5 (problem as severe as can be) on the SNOT-20 based on the previous two weeks. The total SNOT-20 score was defined as the mean value of the response of the 20 items. A mean score was calculated for each of the four subsets. An improvement of 0.8 points or more can be considered a MID in CRS patients (91).

8.5.3 SF-36

The patients were asked to complete the SF-36 (SF-36v2) based on the previous four weeks. The use and scoring of the SF-36 questionnaire were performed according to approved license and scoring protocols (101).

The SF-36 manual proposes domain-specific MID values based on t-scores (101). T-scores are transformed metric (0-100) scores based on US population norms. Since these t-score differences may relate differently to external criteria, and because normative SF-36v2 data from the Norwegian population are unavailable, an approach based on ½ SD was used to estimate MID in article 3 (102). Under

supplementary results in this thesis, also an improvement of 10 points or more was used to define MID in SF-36 domains (100).

8.5.4 Acoustic Rhinometry (AR)

Nasal minimal cross-sectional area (MCA) and nasal cavity volume (NCV) were assessed with an impulse Acoustic Rhinometer (RhinoMetrics SRE 2100, Rhinoscan Version, Interacoustics, Minneapolis, MN), which was handled by specially trained nurses. Anatomic nose-pieces with contact gel between the nose-piece and the nostril were used. The patient was sitting upright, and the measurements were conducted during breath-holding and according to published protocols (135)(Photo 1). The patients were instructed not to use local nasal decongestants 12 hours before testing.

Photo 1. AR, published with consent from the volunteer

The AR values represent an average of three satisfactory recordings from the right and left nasal cavity; they were averaged to get an overall mean value due to the variations of the nasal cycle. An average of each nasal cavity (narrow and wide side) was also calculated. The following measures were recorded: (MCA) in cm^2 from 0 to 3 cm($MCA_{0\text{-}3}$), 3 to 5.2 cm($MCA_{3\text{-}5.2}$), and 0 to 5.2 cm($MCA_{0\text{-}5.2}$) behind the

nostril; and (NCV) in cm^3 from 0 to 3 cm(NCV_{0-3}), 3-5.2 cm($NCV_{3-5.2}$), and 0 to 5.2 cm($NCV_{0-5.2}$) behind the nostril. Nasal decongestants were not used during AR measurements.

An MCA value of 0.4 cm^2 or smaller on the narrow side is suggested to represent a critical value for nasal obstruction (136).

8.5.5 Peak nasal inspiratory flow PNIF

Peak nasal inspiratory flow was assessed with a portable PNIF meter (In-check DIAL; Clement Clarke International, Harlow, Essex, UK). PNIF consists of a nasal mask which the patient holds over the nose and mouth without distorting the alar sidewalls of the upper lateral cartilages. The test was performed with the patient in a sitting position, and the patient was instructed to inhale as hard as possible through the nose with the mouth closed, starting at full expiration (Photo 2). After three sets of satisfactory maximal inspirations, a mean value was calculated (137). In PNIF, an improvement of 20 l/min or more can be used to estimate MID (138).

Photo 2: PNIF, published with consent from the volunteer

8.6 Statistics

All analysis was performed using PASW Statistics, version 23 for Windows (SPSS Inc. Chicago, Illinois). The data were tested for normal distribution. Smoking status was dichotomized as daily smoker or nonsmoker. Comorbidity as asthma, allergy, ASA intolerance or sleep apnea were self-reported. Previous surgery was verified through the patient's medical records.

In paper 1, the mean value ± SD was used to describe continuous variables as symptoms and HRQOL. Categorical variables were presented as numbers (%). Baseline characteristics between the three groups were compared using the independent-sample *t*-test and chi-square test, as appropriate. The Wilcoxon signed ranked test was applied to measure the difference in mean of paired observations before and after surgery. The Mann-Whitney U test was used for comparison of means between groups. P-values less than 0.05 were considered statistically significant. Power calculations showed that with 40 patients in each group and a significance level of 0.05 (alpha), we were able to detect a difference in SNOT-20 of 0.6 (SD1.2) between the groups with 80 percent power.

In paper 2, the mean value ± SD was used to describe continuous variables as MCA, NCV, PNIF, and subjective nasal obstruction (SNO). Categorical variables were presented as numbers (%). Baseline characteristics between the groups were compared using the independent-sample *t*-test and chi-square test, as appropriate. The Wilcoxon signed ranked test was applied to measure the difference in mean of paired observations before and after surgery. The Mann-Whitney U Test was used for comparison of means between groups.

Spearman's rank correlation coefficient was used for the analysis of statistical dependence between MCA, NCV, and PNIF and SNO. Due to multiple testing, *p-values* ≤ 0.01 were considered statistically significant.

In paper 3, the mean value with confidence intervals (CI) was used to describe continuous variables. Categorical variables were presented as numbers (%). Baseline characteristics between the three 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, independent and paired t-tests with corresponding CI were used to analyze data describing symptoms and HRQOL at baseline and follow-up and for unadjusted comparison of outcomes for the two groups. *P-values* ≤ 0.05 were considered clinically significant.
Linear regression analysis was used to investigate variables associated with the improvement in SF-36 domain scores and SNOT-20 scores. Univariable analysis was used to identify variables associated significantly (*p≤ 0.05)* 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 groups separately.

Missing data: When at least 50 percent of the SNOT-20 items had been completed, a mean value of the remaining items was calculated without imputation. When at least 50 percent of the SF-36 items in the same subscale were completed, simple mean imputation was performed. This means that the mean value of the completed item is used as the value of the missing data.

9 Main results

9.1 Study 1

In this study, we compared symptoms and HRQOL in and within three patient groups that underwent septoplasty alone, septoplasty combined with RFIT, and RFIT alone. Symptoms on VAS, disease-specific and generic HRQOL on SNOT-20 and SF-36 were measured before and six months after surgery.

All groups reported statistical improvement in symptoms and SNOT-20. The septoplasty combined with RFIT group achieved a mean improvement in SNOT-20 of 0.8 points or more.

In SF-36 domains, the septoplasty groups reported improvement in PF, RP and VT, while the RFIT group reported improvement in GH and VT after surgery.

The septoplasty groups reported larger improvement in SNO, snoring, and oral breathing, and the septoplasty combined with RFIT also reported larger improvement in sneezing and in SNOT-20 compared to the RFIT group. In SF-36 domains, no difference in improvement was found among the groups.

9.2 Study 2

In study 2, we compared nasal areas (MCA), volumes (NCV), and airflow (PNIF) in the same patient groups as in study 1. We also examined the correlation between the physical measures and the patients' subjective nasal obstruction (SNO). MCA and NCV were measured in cm at two distances behind the nostrils ($MCA/NCV_{0\text{-}3.0}$ and $MCA/NCV_{3\text{-}5.2}$), in addition to PNIF and SNO before and six months after surgery.

Preoperatively, the septoplasty groups had narrower $MCA/NCV_{0\text{-}3.0}$ on one side than the RFIT group. After surgery, total $MCA_{0\text{-}3.0}$ and $MCA/NCV_{3\text{-}5.2}$ increased in the

septoplasty group. In the septoplasty combined with RFIT group, $MCA_{0\text{-}3.0}$ at the narrow side and total $MCA/NCV_{3\text{-}5.2}$ increased, while only total $MCA/NCV_{3\text{-}5.2}$ increased in the RFIT group. PNIF improved in all groups after surgery. A significant moderate correlation was found postoperatively between $MCA/NCV_{3\text{-}5.2}$ and SNO in the septoplasty group.

9.3 Study 3

In study 3, we examined HRQOL and symptoms in CRS patients in two patient groups, CRS with (CRSwNP) and without nasal polyps (CRSsNP), that underwent FESS and identified preoperative patient factors associated with HRQOL outcome in the two groups separately. SF-36, SNOT-20, and VAS were used to measure HRQOL and symptoms before and six months after FESS.

Preoperatively, CRSwNP patients reported worse scores in symptoms of SNO, nasal discharge, and altered sense of smell, worse scores in the SNOT-20 rhinologic subset, and worse scores in the SF-36 GH domain, compared to CRSsNP patients. CRSsNP patients reported worse symptom scores of facial pain, worse scores in the ear/face subset in SNOT-20, and worse scores in the SF-36 domains of PR and BP compared to CRSwNP patients. After surgery, all symptoms, SNOT-20, and all SF-36 domains improved in both groups. Based on the ½ SD approach, a MID was found in the domains of VT, SF, and MH in both groups, in GH in the CRSwNP group, and in PR and BP in the CRSsNP group.

CRSwNP patients had greater improvement in SNO and altered sense of smell and in the SF-36 domains of GH, VT, and SF 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.

9.4 Supplementary results

In this thesis we performed supplementary assessment of MID in the outcomes that are not included in the articles.

In study 1, mean improvement ≥ 30 mm in SNO was achieved in all three groups, and in oral breathing and reduced general health in the septoplasty groups. The mean improvement of SF-36 domains was not ≥ 10 points for any of the groups.

In study 2, mean improvement in PNIF ≥ 20 l/min was achieved in all groups. In AR measures, no MID value was defined. Instead, we investigated whether MCA on the narrowest side was ≤ 0.4 cm^2. Preoperatively, the mean MCA value was ≤ 0.4 cm^2 or less in all patient groups. Postoperatively, the mean MCA on the same side was ≥ 0.4 cm^2 in all groups.

In study 3, the mean improvement in SNO was ≥ 30 mm in both groups, in altered sense of smell in the CRSwNP group, and in sinus pressure in the CRSsNP group. The mean improvement in SNOT-20 was > 0.8 points in both groups. In SF-36 domains, the mean improvement was ≥ 10 points in RP, BP, SF, and MH in both groups, and in VT in the CRSwNP group.

Proportions of patients that achieved the defined MID values in symptoms, SNOT-20 SF-36 and PNIF, and MCA equal to or less than 0.4 cm^2 are presented in tables in the appendix. (Supplementary tables 1-3)

10 Discussion

The main results of this thesis are as follows:

The three patient groups that underwent septoplasty alone, septoplasty combined with RFIT, or RFIT only had preoperatively fairly similar symptoms and HRQOL scores. After surgery, all patient groups reported statistically significant improvement in symptoms and HRQOL, larger nasal area and volumes, and increased airflow. The septoplasty groups reported more improvement in SNO, snoring, and oral breathing compared to the RFIT group. The septoplasty combined with the RFIT group achieved more improvement in SNOT-20 than the RFIT group. Both septoplasty groups reported improvement in five SF-36 domains compared to two domains in the RFIT group.

Also, MCA and NCV improved in all groups after surgery but in different areas in the nasal cavity. In the septoplasty groups, both the anterior and more posterior MCA and NCV improved, while only the more posterior MCA and NCV improved in the RFIT only group. PNIF improved in all groups.

The two CRS groups differed in symptoms and HRQOL preoperatively. The CRSwNP group reported more SNO, altered sense of smell, nasal discharge, and a worse score in the rhinologic subset of SNOT-20 compared to the CRSsNP group. The CRSsNP group reported more facial pain and sinus pressure, worse scores in the ear/facial subset of SNOT-20 and the SF-36 domains RP and BP than the CRSwNP group.

After surgery, both CRS groups reported statistically significant improvement in symptoms and HRQOL. The CRSwNP group reported more improvement in the SF-36 domains of GH, VT, and SF compared to the CRSsNP group. Age, smoking, and

previous sinus surgery were associated with less improvement in both groups, in addition to female sex and allergy in the CRSsNP group.

10.1 Methodological considerations

Design

This thesis consists of three observational studies that are based on prospectively collected register data performed on five patient groups, where subjective and physical measures were investigated to evaluate outcomes after septoplasty, RFIT, and sinus surgery.

Internal validity

Internal validity refers to our ability to trust the results in the study and is determined by how well a study can rule out alternative explanations for the findings. The aim is to reduce possible confounders or random variables that influence our results. Correct patient selection, valid and reliable test instruments, uniformly performed surgical procedures and follow-up regimes are factors that can strengthen internal validity. All patients in our studies were diagnosed and referred for surgery by senior consultants and registrars at the outpatient clinic of the ENT department St. Olav. The collection of subjective and physical data before and after surgery was done in a planned and standardized manner. The surgery was performed by a variety of surgeons, which may involve some variations in surgical experience; however, we have no reason to believe this has led to systematic bias in our results. The follow-up regime and controls were also conducted after standardized routines.

In self-reported data, there are some types of bias that may influence the results such as, for example, recall bias, response bias, and acquiescence bias.

To reduce the risk of recall bias, the patients were asked to consider the symptom scores on VAS and SNOT-20 based on the previous two weeks and the previous four weeks on SF-36.

Response bias is prevalent in studies where self-reporting is involved and occurs when patients are affected not only by their true response to a question but also by how the question is worded or by their motivations (74). It can be related to any part of the process where patients are asked to produce a response. One specific type of response bias is acquiescence bias, where the subjects will tend to agree on statements they think is correct or the investigator will like to hear or will be beneficial to the study or themselves (74).

In our study, the patients answered the questionnaires in a private area and were assured by trained nurses that their privacy was protected and that no answers were considered incorrect or could influence the planned health care with support. Another way of reducing response bias would be to conduct the survey online without the interference of health personnel.

The fact that patients learn to cope with problems is a well-recognized feature in the chronically ill (100), and the subjective changes in patients' perspective may lead to a recalibrating of their internal standards and values, also referred to as response shift (139-141). It is less likely this phenomenon occurs during a short follow-up period of six months as in our material, but it may be present in some of our patients with a long duration of disease. In general, this may be an important methodical issue in the interpretation of HRQOL measures. Especially when comparing to a

control group or normative values, values from patients may appear more favorable than those from population-based reference groups (100).

Further, it is important that the instruments used must satisfy the criteria for reliability and validity in order to draw valid research conclusions regarding patient-related outcomes as HRQOL (79). The instruments used in our studies are considered valid and reliable instruments for measuring symptoms and HRQOL (87, 91, 98, 99). However, SNOT-20 lacks questions about nasal obstruction and olfaction, causing that all underlying items in the concept of interests are not measured in SNOT-20, regarding content validity (100). This may have influenced our results regarding SNOT-20. The reason for using SNOT-20 in our analysis is that SNOT-20 was the only Norwegian translated version available when we established our register.

Specially trained operators performed AR and PNIF measurements.

During the study period, the PNIF meter was changed from a PNIF meter with a maximal inspiratory flow limit of 120 l/min (In-Check Dial) to a PNIF meter with a maximal inspiratory flow limit of 350 l/min (In-Check Nasal). The manufacturer of both instruments, Clement Clarke International, can confirm that both instruments are calibrated identically, with a performance accuracy of ± 10 percent or 10 l/min (whichever is greater) and repeatability of ± 5 l/min. Thus the results in the range 15-120 l/min will be similar for either instrument.

To ensure the accuracy of the PNIF measures in study 2, 23 patients with a PNIF-value of 120 l/min were excluded from the analysis if the test was performed with the PNIF meter with maximal inspiration flow limit of 120 l/min.

External validity

The studies are observational studies and not randomized controlled studies. Register studies reflect daily clinical practice and can potentially provide robust and externally valid results as RCTs (142).

To ensure external validity, the selection of a representative sample is always important. All patients were recruited from the quality register database at the ENT department at St. Olav's hospital in Trondheim, a tertiary hospital in the county of Trøndelag, with 459,000 inhabitants. The diagnosing of patients included anterior rhinoscopy and nasal endoscopy combined with patients' symptoms in patients with septum deviation and ITH, in addition to EPOS criteria and CT findings in CRS patients.

The external validity of these studies is also dependent on the quality register's completeness of data. The routine of including patients in the register is very well implemented in the outpatient clinic with a high inclusion rate and completeness of data. However, not all patients included in the register undergo surgery. Those patients were excluded from our studies.

In all patient groups, the follow-up rate after surgery was between 83-95 percent, except for in the RFIT group where the follow-up rate was 67 percent.

Thus, we consider that our results may be generalized with caution to similar patient groups that undergo the same type of surgical treatment in a tertiary hospital in developed countries.

10.2 Discussion of main results

10.2.1 Patients undergoing septoplasty with or without RFIT and RFIT only

The statistical improvement in SNO, nasal discharge, snoring, oral breathing, and affected general health, total SNOT-20, and several SF-36 domains in our patient groups are similar to results from other studies investigating symptoms and HRQOL after septoplasty with or without reduction of ITH (24, 58, 118). Previous studies on surgical management of ITH have also reported positive subjective results similar to ours (27, 49, 119).

Our patient groups reported statistical improvement in both SNOT-20 and SF-36 summary scores of physical and mental health after surgery. Other studies on similar patients reported improvement in disease-specific HRQOL, but not in generic HRQOL(122, 124). However, a study by Croy et al.(58) reported improvement in the SF-36 domains of PF, GH, VT, and SF after septoplasty, which supports the results in our septoplasty groups where we found improvement in the same domains.

The RFIT group also reported improvement in all symptoms except for sneezing, and in SNOT-20. Harrill et al.(119) compared patients undergoing septoplasty combined with RFIT and RFIT only and found improvement in both groups in disease-specific HRQOL using the NOSE scale. No differences between groups were found, possibly due to the small sample size with only nine patients in the septoplasty group compared to 67 patients in the RFIT group. Nevertheless, the improvement in disease-specific HRQOL coincides with our results in the RFIT group. The SF-36 summary scores of physical *(p=0.05*) and mental health improved after surgery, reflecting improvement in the domains of GH and VT.

Also, the physical measures, MCA, NCV, and PNIF improved in all three groups after surgery. The improvement in MCA and NCV appeared in different locations in the nasal cavity, and a moderate correlation was found between increased MCA/NCV and less SNO in the septoplasty group. Other studies have reported results similar to ours, that septoplasty and RFIT improve nasal geometry (113, 118, 136). Contradicting results were reported in a study by Reber et al.(143), who found neither a change in MCA nor a correlation with subjective complaint in patients undergoing septoplasty. However, this study consisted of only 27 patients.

10.2.1.1 Comparing outcomes after surgery among the patient groups

The original design of our study permits the comparison of outcomes among the three patient groups. When we compared the two septoplasty groups, with or without RFIT, we found no differences in the improvement of symptoms, SNOT-20, or SF-36. A study by Akduman et al.(116) using other HRQOL instruments shows similar results.

Both septoplasty groups reported more improvement in SNO, snoring, and oral breathing than the RFIT only group. The septoplasty combined with RFIT group also reported more improvement in SNOT-20 than the RFIT only group.

Although the improvement in the SF-36 summary scores of physical and mental health was similar among the three groups, the septoplasty groups reported improvement in five domains compared to two domains in the RFIT group. This may indicate not only that more domains improved in the septoplasty groups but also that different aspects of generic HRQOL were affected in the groups after surgery.

To interpret only the SF-36 summary scores may be tempting due to its simplicity, but these should be accompanied by domain scores (144) to give a more

comprehensive impression of the patient's generic HRQOL. We may believe that the septoplasty groups improved in more physical aspects of generic HRQOL, according to the improvement in PH and RP domains. The improvement in GH and VT in the RFIT group implies an improvement in more mental aspects of HRQOL. However, this is only speculation, and we failed to show any statistically significant difference in domain improvement among the groups.

There may be several explanations for the differences among the groups regarding the improvement of their symptoms and HRQOL.

First, the explanations can be related to anatomic and structural factors in the nasal cavity. Septoplasty with or without RFIT involves the nasal valve, which is the narrowest site in the nasal cavity where very small changes in nasal area and volumes can have large consequences for nasal patency. Improvement in both anterior and more posterior MCA and NVC in the septoplasty groups may have led to greater improvement in symptoms and HRQOL in these two groups compared with the RFIT only group where the MCA and NCV improved only in the more posterior areas of the nasal cavity.

We may also speculate that the preoperatively smaller MCA at the narrow side in the septoplasty groups contributed to a larger potential for improvement in the patients' sensation of SNO. A study by Pirilä et al.(125) suggested that nasal complaints of obstruction originate from the most obstructed side.

It is also possible that surgery on dynamic structures such as ITH is more challenging than surgery involving bone and cartilage. Studies have shown that improvement in SNO after turbinate surgery may diminish over time (60).

Demographic factors such as more women in the RFIT group can have affected the outcome in this group compared to the septoplasty only group. Studies have shown that women tend to report poorer symptoms and HRQOL scores than men (145, 146). However, this cannot explain the differences in outcomes between the septoplasty combined with RFIT and the RFIT only groups where the distribution of gender was similar.

Sneezing, which may be a symptom of allergy, was not improved in the RFIT group after surgery. The distribution of allergy was similar in the groups, but the diagnosis of allergy was done by self-reporting. We cannot rule out that some allergy patients were not identified in this group and that this influenced the results.

The choice of surgical procedure is made on indication. It is possible that some of the patients in the RFIT group had a septum deviation, which was mistakenly not considered to cause symptoms, or finally, that RFIT is less effective in improving the patients symptoms and HRQOL.

Further explanations for the differences in HRQOL outcomes among the patient groups may be in regard to the minor preoperative differences in disease-specific HRQOL between the septoplasty only and the RFIT groups. The patients in the RFIT group reported worse problems in the ear/face subset of SNOT-20 compared to the septoplasty only group, but not compared to the other septoplasty group.

The HRQOL instruments may also have affected the results. The lack of questions concerning SNO and olfaction in SNOT-20 has been mentioned before. Also floor- and ceiling effects could have influenced the results, and a generic instrument as the SF-36 is known to be less sensitive in detecting small changes.

Finally, we must bear in mind that the three patient groups were not similar and that different conditions were the cause of nasal obstruction and decreased HRQOL. We aimed to investigate and compare different outcomes in three frequently performed ENT procedures in a descriptive manner more than to suggest causalities.

Previous surgery and comorbidity

Our study showed that in revision cases, patients with sleep apnea and asthma had a poorer outcome in some symptoms and HRQOL measures after surgery than other patients. This information underscores the importance of performing a comprehensive assessment of the patient's subjective measures and comorbidity in order to select the optimal treatment and provide realistic expectations of the outcome. Compliance with the treatment of the comorbidities should also be emphasized.

MID in outcomes after septoplasty and RFIT

Based on the criteria we have used for MID, we consider the statistically significant improvement in symptoms and SNOT-20 to be meaningful for many of our patients but not for all. In SNO, 61 percent, 71 percent, and 45 percent of the patients in the respective groups achieved MID. In SNOT-20, 42 percent and 48 percent of the patients in the septoplasty groups achieved MID, while 28 percent of the patients in the RFIT group achieved MID. This implies the need for further research to investigate what characterizes the patients who achieved MID after surgery.

We are aware that SNOT-20 lacks questions about SNO and olfaction, but the instrument covers a variety of other relevant sino-nasal aspects that should be considered. In future studies, the use of SNOT-22 would possibly show different results.

The mean improvement in SF-36 was not 10 points or more in any of the groups. However, improvement less than 10 points can also be meaningful for the patients.

Regarding the physical measures, all patient groups achieved a MID in PNIF according to the mean improvement of more than 20 l/min.

In AR, the mean MCA in the most obstructed side preoperatively increased above the critical value of 0.4 cm^2 after surgery in all groups. We did not compare outcomes among patient groups based on this value. However, such comparisons could provide important knowledge, and in combination with SNO, this measure could be helpful in the preoperative assessment and choice of treatment.

Comparison with normative values

The septoplasty group combined with RFIT ended up having the best postoperative scores among the groups; SNO of 28 mm on VAS and 0.9 in SNOT-20. However, these scores were still above the same scores reported in asymptomatic individuals; SNO score between 9-16 mm on VAS or a SNOT-20 score of 0.4 (3, 93, 95). In regard to SF-36, the scores also seemed lower than normative scores from a Norwegian population, but firm conclusions cannot be made due to differences in SF-36 versions. After surgery in our patient groups, MCA most anteriorely was still smaller, while PNIF was in line with values from individuals without nasal complaints (147, 148).

Inconsistency between subjective and physical measures

As noted earlier, we found a correlation between increased MCA/NCV and less SNO after surgery in the septoplasty only group. This may strengthen the

conception that septoplasty was effective in improving nasal patency and thereby SNO. However, we cannot make valid assumptions about causative factors. Inconsistency between nasal patency measured with AR and other physical methods and the patients' subjective feeling of nasal obstruction is not necessarily a disadvantage. Subjective and physical measures are complementary tools in the assessment of the patient. The lack of consistency between subjective and physical measures can be helpful in deciding *if and when* to perform a surgical intervention and can also be helpful in informing patients about expectations of outcome. Finally, it may be a signal to look for other causes of the patients' complaints.

10.2.2 CRSwNP and CRSsNP patients undergoing FESS

It is important to underscore the preoperative differences in symptoms and HRQOL in the two CRS groups. Preoperatively, the CRSwNP group reported more SNO, altered sense of smell, and nasal discharge and a worse score in the rhinologic subset of SNOT-20 compared to the CRSsNP group. The latter group reported more facial pain and sinus pressure, a worse score in the ear/facial subset of SNOT-20, and worse scores in the PR and BP domains in SF-36 compared to the CRSwNP group. These results are supported by other studies, where Bugten et al.(41) found that CRSwNP patients reported more SNO and decreased olfaction compared to CRSsNP patients, who reported more facial pain. Smith et al.(134) also found that CRSsNP patients had poorer disease-specific and generic HRQOL compared to CRSwNP patients using other HRQOL instruments. Another study, using SF-36, reported more BP in CRSsNP patients compared to CRSwNP patients(38).

After surgery, both CRS groups reported statistical significant improvement in symptoms and disease-specific and generic HRQOL. This is in line with previous studies (44, 130, 149, 150).

10.2.2.1 Comparing outcomes among the CRSwNP and CRSsNP groups

The improvement differed among the groups, where the CRSwNP group reported more improvement in SNO and olfaction than the CRSsNP group, which reported more improvement in facial pain. Considering the differences in the preoperative scores, this was not unrealistic to expect regarding a greater potential for improvement.

The improvement in SNOT-20 and the four subsets was similar among the two groups. A study by Ragab et al.(44) used the same HRQOL instruments in comparing medical and surgical treatment of CRS patients with and without NP. They stated that they did not find differences in SNOT-20 measures among the CRS groups with or without NP after surgery, which is similar to our findings. That is opposite the results from a study by Deal et al.(131) that reported CRSwNP patients had a preoperatively more severe SNOT-20 score and less improvement after surgery compared to CRSsNP patients.

Unfortunately, we are unable to elaborate further on the differences in disease-specific HRQOL among our CRS groups because SNOT-20 lacks questions about SNO and olfaction, and these two symptoms seem to be more present in CRSwNP compared to CRSsNP.

Several studies have reported improvement in SF-36 in CRS-patients after sinus surgery (42, 44, 68, 129, 150). In our study, we found that all SF-36 domains

improved in both CRS groups. This coincides with the findings of Djukic et al.(68) in CRSwNP patients and in the study from Ragab et al.(44) that reported improvement in all domains except for the PF domain in both CRSwNP and CRSsNP patients.

We found that the improvement in the SF-36 domains differed among the groups in favor of the CRSwNP group. This group reported more improvement in GH, VT, and SF domains compared to the CRSsNP group. Another study reported worse MH in CRSsNP after surgery compared to CRSwNP (42), but this was not the case in our study.

There may be several explanations for the differences in improvement in these domains. We may speculate that the worse outset in GH in the CRSwNP group led to a greater potential for improvement; however, the improvement exceeded the preoperative difference. Hence, there was a greater improvement in GH, VT, and SF in the CRSwNP group compared to the CRSsNP group after surgery.

BP seems to be a common complaint in CRS patients, where BP in CRS patients is found to be below population norms (132). A study from Sahlstrand-Johnson on CRS patients awaiting sinus surgery (38) found that BP was more present in CRSsNP patients than in CRSwNP patients. In our study, BP was the domain that differed most among the groups both before and after surgery in disfavor of the CRSsNP group. This issue should be empazised in the assessment of CRSsNP patients and the patients should be counseled accordingly.

Gender differences may also be a contributing explanation to the differences in HRQOL between the two CRS groups. More women in the CRSsNP group may have influenced our results, previous studies on HRQOL in CRS patients have shown that women tend to report higher scores than men (146, 151).

Patient factors associated with outcome

In tailoring the right treatment to the patient, it is of paramount importance to identify patient factors that may influence the outcome after surgery. Our study found, in both groups, that a more severe preoperative SNOT-20 value was associated with more SNOT-20 improvement after surgery. The same result is found in similar studies using SNOT-22 (42, 126, 128). The association between more severe preoperative scores and larger improvement was also the case regarding the SF-36 outcome. Factors such as age, smoking, and previous sinus surgery were associated with less improvement in SF-36 domains in both groups, in addition to female sex and allergy in the CRSsNP group. This information should be emphasized when planning for surgery and informing the patients about expectations of the outcome.

In future research, factors such as, for example, marital status or education level, which are important factors associated with health outcome (152), should also be taken into account to provide an even more comprehensive basis for evaluation of HRQOL.

MID in improvement after FESS

The mean improvement in total SNOT-20 was 0.9 points in both CRS groups, which is above the suggested MID value of 0.8. This improvement was achieved in 56 percent in the CRSwNP group and 52 percent of the CRSsNP group. Although the study from Hopkins et al.(126) used the SNOT-22 instrument, the proportions of patients who reached a meaningful change reflected a similar result to ours; 69 percent in CRSwNP patients and 61 percent in CRSsNP patients, indicating that CRSwNP patients profit more from sinus surgery than CRSsNP patients.

Regarding SF-36, a mean improvement of 10 points or higher was found in RP, BP, SF, and MH in both groups and in VT in the CRSwNP group. Due to the improvement in several domains in both CRS groups, we consider that both patient groups achieved a meaningful improvement in several aspects of generic HRQOL.

Comparison with normative values

Although the CRS groups had worse symptoms and SNOT-20 scores before surgery compared to subjects without CRS from the same geographic area using the same measuring instruments (93), the symptoms and SNOT-20 scores were still worse after surgery. This is not surprising due to the chronic nature of CRS. The relapse rate in CRSwNP tends to be higher compared to CRSsNP (36). Hence, this emphasizes the importance of medical treatment of CRS also after surgery. SF-36 also showed worse than normative values from a Norwegian population (153), but we cannot explore this in a valid manner as the normative values are based on SF-36 version 1.

11 Conclusions

We have shown that a combination of subjective and physical measures can be used as determiners of outcome in nose and sinus surgery and that research based on registry data may provide valuable evidence-based knowledge.

Our main conclusions are as follows:

- The patient groups that undergo septoplasty, septoplasty combined with RFIT, or RFIT only report improvement in symptoms and HRQOL after surgery. The septoplasty groups report larger improvements in symptoms and HRQOL compared to patients undergoing RFIT only.

- MCA and NCV improve in all three groups after surgery but in different locations in the nasal cavity. MCA/NCV increases both anteriorly and more posteriorly in the septoplasty groups but only more posteriorly in the RFIT group.

- The CRSwNP and CRSsNP groups report improvement in symptoms and HRQOL after sinus surgery. CRSwNP patients report greater improvement in SNO and altered olfaction and in the generic domains of GH, VT, and SF compared to CRSsNP patients.

Higher age, daily smoking, and previous sinus surgery were associated with less generic HRQOL improvement in both groups, in addition to female sex and allergy in the CRSsNP group.

12 Implications for practice

The use of both subjective and physical measures has provided valuable knowledge about our patient groups before and after surgery. This knowledge can be helpful in patient selection and in informing patients and health personnel of expectations of the outcome after surgery.

The results from studies 1 and 2 imply that when doubt exists about whether the anatomic cause of the nasal obstruction is a septum deviation or ITH, based on the varying outcomes in symptoms and HRQOL, a combination procedure may be wise.

AR measures can be helpful not only in the evaluation of surgery but also in the preoperative assessment of the patient.

Precautions in the choice of surgical technique should be taken. There are reasons to believe that some clinicians may try RFIT as the first attempt to reduce nasal obstruction although there is an anterior septum deviation present because RFIT is an easy and less painful procedure. This will have a limited impact on the airflow in the anterior part of the nasal cavity.

CRSsNP patients seem to profit less from sinus surgery in regard to generic HRQOL, which has implications for the expectations of the outcome. More evidence for enhanced medical treatment should be investigated.

Locally, the *main implication for future practice* is that the results from this thesis will inspire surgeons to perform a more comprehensive assessment, including both subjective and physical measures, of the patients in order to tailor the right treatment and optimize the outcome.

13 Future research

A natural consequence of our studies is further analysis of the existing material of the patients who not achieved improvement in subjective and physical outcomes after surgery. A following study on similar patient populations using SNOT-22 would also be an option.

The use of a qualitative research method such as, for example, interviews of patients undergoing similar surgery could provide important complementary knowledge from the patient's perspective that also may affect HRQOL aspects.

Locally, it would be of the highest interest to perform similar studies on future register data *after* implementation of subjective and physical measures in the preoperative assessment of the patients.

14 References

1. Holmstrom M. The use of objective measures in selecting patients for septal surgery. Rhinology. 2010;48(4):387-93.
2. Pawar SS, Garcia GJ, Kimbell JS, Rhee JS. Objective measures in aesthetic and functional nasal surgery: perspectives on nasal form and function. Facial Plast Surg. 2010;26(4):320-7.
3. Rhee JS, Sullivan CD, Frank DO, Kimbell JS, Garcia GJ. A systematic review of patient-reported nasal obstruction scores: defining normative and symptomatic ranges in surgical patients. JAMA facial plastic surgery. 2014;16(3):219-25; quiz 32.
4. Eccles R. Nasal airflow in health and disease. Acta Otolaryngol. 2000;120(5):580-95.
5. Dhillon RS, East CA. Ear, nose and throat and head and neck surgery : an illustrated colour text. 3rd ed. ed. Edinburgh: Churchill Livingstone/Elsevier; 2006.
6. Berger G, Balum-Azim M, Ophir D. The normal inferior turbinate: histomorphometric analysis and clinical implications. Laryngoscope. 2003;113(7):1192-8.
7. Cole P. The four components of the nasal valve. Am J Rhinol. 2003;17(2):107-10.
8. Hilberg O. Objective measurement of nasal airway dimensions using acoustic rhinometry: methodological and clinical aspects. Allergy. 2002;57 Suppl 70:5-39.
9. Nurse LA, Duncavage JA. Surgery of the inferior and middle turbinates. Otolaryngol Clin North Am. 2009;42(2):295-309, ix.
10. Grymer LF, Hilberg O, Pedersen OF, Rasmussen TR. Acoustic rhinometry: values from adults with subjective normal nasal patency. Rhinology. 1991;29(1):35-47.
11. Rhee JS, Weaver EM, Park SS, Baker SR, Hilger PA, Kriet JD, et al. Clinical consensus statement: Diagnosis and management of nasal valve compromise. Otolaryngol Head Neck Surg. 2010;143(1):48-59.
12. Naito K, Kondo Y, Ohoka E, Komori M, Takeuchi M, Iwata S. New aerodynamic aspects of nasal patency. Rhinology. 1995;33(1):26-9.
13. Courtiss EH, Gargan TJ, Courtiss GB. Nasal physiology. Ann Plast Surg. 1984;13(3):214-23.
14. Pfitzner J. Poiseuille and his law. Anaesthesia. 1976;31(2):273-5.
15. Cole P, Haight JS. Posture and the nasal cycle. Ann Otol Rhinol Laryngol. 1986;95(3 Pt 1):233-7.
16. Lundberg J. Airborne nitric oxide: Inflammatory marker and aerocrine messenger in man. Acta Physiol Scand. 1996;157(S633):4-27.
17. Smith KD, Edwards PC, Saini TS, Norton NS. The prevalence of concha bullosa and nasal septal deviation and their relationship to maxillary sinusitis by volumetric tomography. International journal of dentistry. 2010;2010.
18. Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. AJNR Am J Neuroradiol. 2004;25(9):1613-8.
19. Akoglu E, Karazincir S, Balci A, Okuyucu S, Sumbas H, Dagli AS. Evaluation of the turbinate hypertrophy by computed tomography in patients with deviated nasal septum. Otolaryngol Head Neck Surg. 2007;136(3):380-4.

20. Berger G, Hammel I, Berger R, Avraham S, Ophir D. Histopathology of the inferior turbinate with compensatory hypertrophy in patients with deviated nasal septum. Laryngoscope. 2000;110(12):2100-5.

21. Chandra RK, Patadia MO, Raviv J. Diagnosis of nasal airway obstruction. Otolaryngol Clin North Am. 2009;42(2):207-25, vii.

22. Baumann I. Quality of life before and after septoplasty and rhinoplasty. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2010;9:Doc06.

23. Shedden A. Impact of nasal congestion on quality of life and work productivity in allergic rhinitis: findings from a large online survey. Treat Respir Med. 2005;4(6):439-46.

24. Hytonen ML, Lilja M, Makitie AA, Sintonen H, Roine RP. Does septoplasty enhance the quality of life in patients? Eur Arch Otorhinolaryngol. 2012;269(12):2497-503.

25. Cingi C, Ure B, Cakli H, Ozudogru E. Microdebrider-assisted versus radiofrequency-assisted inferior turbinoplasty: a prospective study with objective and subjective outcome measures. Acta Otorhinolaryngol Ital. 2010;30(3):138-43.

26. Rohrich RJ, Krueger JK, Adams WP, Jr., Marple BF. Rationale for submucous resection of hypertrophied inferior turbinates in rhinoplasty: an evolution. Plast Reconstr Surg. 2001;108(2):536-44; discussion 45-6.

27. Seeger J, Zenev E, Gundlach P, Stein T, Muller G. Bipolar radiofrequency-induced thermotherapy of turbinate hypertrophy: pilot study and 20 months' follow-up. Laryngoscope. 2003;113(1):130-5.

28. Juniper EF. Measuring health-related quality of life in rhinitis. J Allergy Clin Immunol. 1997;99(2):S742-9.

29. Lindemann J, Keck T, Leiacker R, Dzida R, Wiesmiller K. Early influence of bilateral turbinoplasty combined with septoplasty on intranasal air conditioning. Am J Rhinol. 2008;22(5):542-5.

30. Veit JA, Nordmann M, Dietz B, Sommer F, Lindemann J, Rotter N, et al. Three different turbinoplasty techniques combined with septoplasty: Prospective randomized trial. Laryngoscope. 2017;127(2):303-8.

31. Brunworth J, Holmes J, Sindwani R. Inferior turbinate hypertrophy: review and graduated approach to surgical management. American journal of rhinology & allergy. 2013;27(5):411-5.

32. Chaaban MR, Walsh EM, Woodworth BA. Epidemiology and differential diagnosis of nasal polyps. American journal of rhinology & allergy. 2013;27(6):473-8.

33. Hastan D, Fokkens WJ, Bachert C, Newson RB, Bislimovska J, Bockelbrink A, et al. Chronic rhinosinusitis in Europe--an underestimated disease. A GA(2)LEN study. Allergy. 2011;66(9):1216-23.

34. Jarvis D, Newson R, Lotvall J, Hastan D, Tomassen P, Keil T, et al. Asthma in adults and its association with chronic rhinosinusitis: the GA2LEN survey in Europe. Allergy. 2012;67(1):91-8.

35. Shashy RG, Moore EJ, Weaver A. Prevalence of the chronic sinusitis diagnosis in Olmsted County, Minnesota. Arch Otolaryngol Head Neck Surg. 2004;130(3):320-3.

36. Fokkens WJ, Lund VJ, Mullol J, Bachert C, Alobid I, Baroody F, et al. EPOS 2012: European position paper on rhinosinusitis and nasal polyps 2012. A summary for otorhinolaryngologists. Rhinology. 2012;50(1):1-12.

37. Larsen K, Tos M. The estimated incidence of symptomatic nasal polyps. Acta Otolaryngol. 2002;122(2):179-82.
38. 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(4):420-8.
39. Craig TJ, Ferguson BJ, Krouse JH. Sleep impairment in allergic rhinitis, rhinosinusitis, and nasal polyposis. Am J Otolaryngol. 2008;29(3):209-17.
40. Aaseth K, Grande RB, Kvaerner K, Lundqvist C, Russell MB. Chronic rhinosinusitis gives a ninefold increased risk of chronic headache. The Akershus study of chronic headache. Cephalalgia. 2010;30(2):152-60.
41. Bugten V, Nordgard S, Romundstad P, Steinsvag S. Chronic rhinosinusitis and nasal polyposis; indicia of heterogeneity. Rhinology. 2008;46(1):40-4.
42. Sahlstrand-Johnson P, Hopkins C, Ohlsson B, Ahlner-Elmqvist M. The effect of endoscopic sinus surgery on quality of life and absenteeism in patients with chronic rhinosinuitis - a multi-centre study. Rhinology. 2017;55(3):251-61.
43. Soler ZM, Wittenberg E, Schlosser RJ, Mace JC, Smith TL. Health state utility values in patients undergoing endoscopic sinus surgery. Laryngoscope. 2011;121(12):2672-8.
44. 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(3):305-11.
45. Bhattacharyya N, Lee LN. Evaluating the diagnosis of chronic rhinosinusitis based on clinical guidelines and endoscopy. Otolaryngol Head Neck Surg. 2010;143(1):147-51.
46. De Greve G, Hellings PW, Fokkens WJ, Pugin B, Steelant B, Seys SF. Endotype-driven treatment in chronic upper airway diseases. Clinical and translational allergy. 2017;7:22.
47. Brescia G, Zanotti C, Parrino D, Barion U, Marioni G. Nasal polyposis pathophysiology: Endotype and phenotype open issues. Am J Otolaryngol. 2018;39(4):441-4.
48. Bayar Muluk N, Cingi C, Scadding GK, Scadding G. Chronic Rhinosinusitis-Could Phenotyping or Endotyping Aid Therapy? American journal of rhinology & allergy. 2019;33(1):83-93.
49. Batra PS, Seiden AM, Smith TL. Surgical management of adult inferior turbinate hypertrophy: a systematic review of the evidence. Laryngoscope. 2009;119(9):1819-27.
50. Mygind N, Lildholdt T. Nasal polyps treatment: medical management. Allergy Asthma Proc. 1996;17(5):275-82.
51. Bugten V. Effects of postoperative measures after functional endoscopic sinus surgery [Doctoral thesis at NTNU]: NTNU; 2008.
52. Valero A, Navarro AM, Del Cuvillo A, Alobid I, Benito JR, Colas C, et al. Position paper on nasal obstruction: evaluation and treatment. J Investig Allergol Clin Immunol. 2018;28(2):67-90.
53. Han JK, Stringer SP, Rosenfeld RM, Archer SM, Baker DP, Brown SM, et al. Clinical Consensus Statement: Septoplasty with or without Inferior Turbinate Reduction. Otolaryngol Head Neck Surg. 2015;153(5):708-20.
54. van Egmond M, Rovers MM, Hannink G, Hendriks CTM, van Heerbeek N. Septoplasty with or without concurrent turbinate surgery versus non-surgical

management for nasal obstruction in adults with a deviated septum: a pragmatic, randomised controlled trial. Lancet. 2019;394(10195):314-21.

55. Jessen M, Malm L. Definition, prevalence and development of nasal obstruction. Allergy. 1997;52(40 Suppl):3-6.

56. Dabrowska-Bien J, Skarzynski PH, Gwizdalska I, Lazecka K, Skarzynski H. Complications in septoplasty based on a large group of 5639 patients. Eur Arch Otorhinolaryngol. 2018;275(7):1789-94.

57. Chidambaram A, Nigam A, Cardozo AA. Anticipated absence from work ('sick leave') following routine ENT surgery: are we giving the correct advice? A postal questionnaire survey. Clin Otolaryngol Allied Sci. 2001;26(2):104-8.

58. Croy I, Hummel T, Pade A, Pade J. Quality of life following nasal surgery. Laryngoscope. 2010;120(4):826-31.

59. Sundh C, Sunnergren O. Long-term symptom relief after septoplasty. Eur Arch Otorhinolaryngol. 2015;272(10):2871-5.

60. Bergmark RW, Gray ST. Surgical Management of Turbinate Hypertrophy. Otolaryngol Clin North Am. 2018;51(5):919-28.

61. Ye T, Zhou B. Update on surgical management of adult inferior turbinate hypertrophy. Curr Opin Otolaryngol Head Neck Surg. 2015;23(1):29-33.

62. Clement WA, White PS. Trends in turbinate surgery literature: a 35-year review. Clin Otolaryngol Allied Sci. 2001;26(2):124-8.

63. Tajudeen BA, Kennedy DW. Thirty years of endoscopic sinus surgery: What have we learned? World journal of otorhinolaryngology - head and neck surgery. 2017;3(2):115-21.

64. Bugten V, Nordgard S, Skogvoll E, Steinsvag S. Effects of nonabsorbable packing in middle meatus after sinus surgery. Laryngoscope. 2006;116(1):83-8.

65. Bugten V, Nordgard S, Steinsvag S. The effects of debridement after endoscopic sinus surgery. Laryngoscope. 2006;116(11):2037-43.

66. Bugten V, Nordgard S, Steinsvag S. Long-term effects of postoperative measures after sinus surgery. Eur Arch Otorhinolaryngol. 2008;265(5):531-7.

67. May M, Levine HL, Mester SJ, Schaitkin B. Complications of endoscopic sinus surgery: analysis of 2108 patients--incidence and prevention. Laryngoscope. 1994;104(9):1080-3.

68. 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(1):83-9.

69. Beswick DM, Mace JC, Soler ZM, Ayoub NF, Rudmik L, DeConde AS, et al. Appropriateness criteria predict outcomes for sinus surgery and may aid in future patient selection. Laryngoscope. 2018.

70. 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(6):798-803.

71. Rothman ML, Beltran P, Cappelleri JC, Lipscomb J, Teschendorf B. Patient-reported outcomes: conceptual issues. Value Health. 2007;10 Suppl 2:S66-75.

72. Bowling A. Research Methods in Health: Investigating Health and Health Services [NTNU University Library]2014.

73. Post MW. Definitions of quality of life: what has happened and how to move on. Topics in spinal cord injury rehabilitation. 2014;20(3):167-80.

74. Spilker B. Quality of Life and Pharmacoeconomics in Clinical Trials. 2nd ed: Lippincott- Raven; 1996.
75. WHO. WHOQOL: Measuring Quality of Life [web-page]. [updated 20.05.2019. Available from: https://www.who.int/healthinfo/survey/whoqol-qualityoflife/en/.
76. Wahl AK, Hanestad, Berit Rokne. Målng av livskvalitet i klinisk praksis. En innføring. Book 2004. p. 155.
77. Wallander JL, Koot HM. Quality of life in children: A critical examination of concepts, approaches, issues, and future directions. Clin Psychol Rev. 2016;45:131-43.
78. Moons P, Budts W, De Geest S. Critique on the conceptualisation of quality of life: a review and evaluation of different conceptual approaches. Int J Nurs Stud. 2006;43(7):891-901.
79. Bowling A. Measuring disease
A review of disease-spesific quality of life measurements scales. Second ed. Open University Press2001.
80. Cella DF, Tulsky DS. Measuring quality of life today: methodological aspects. Oncology (Williston Park). 1990;4(5):29-38; discussion 69.
81. Bowling A. The concept of quality of life in relation to health. Med Secoli. 1995;7(3):633-45.
82. Ware JE, Jr. Standards for validating health measures: definition and content. J Chronic Dis. 1987;40(6):473-80.
83. 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(6):1532-40.e2.
84. Remenschneider AK, D'Amico L, Gray ST, Holbrook EH, Gliklich RE, Metson R. The EQ-5D: a new tool for studying clinical outcomes in chronic rhinosinusitis. Laryngoscope. 2015;125(1):7-15.
85. Gliklich RE, Hilinski JM. Longitudinal sensitivity of generic and specific health measures in chronic sinusitis. Qual Life Res. 1995;4(1):27-32.
86. 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(6):473-83.
87. Loge JH, Kaasa S, Hjermstad MJ, Kvien TK. Translation and performance of the Norwegian SF-36 Health Survey in patients with rheumatoid arthritis. I. Data quality, scaling assumptions, reliability, and construct validity. J Clin Epidemiol. 1998;51(11):1069-76.
88. Guyatt GH, Bombardier C, Tugwell PX. Measuring disease-specific quality of life in clinical trials. CMAJ. 1986;134(8):889-95.
89. Takhar A, Stephens J, Randhawa PS, Poirrier AL, Andrews P. Validation of the sino-nasal outcome test-23 in septorhinoplasty surgery. Rhinology. 2014;52(4):301-4.
90. Tait SD, Kallogjeri D, Chidambaram S, Schneider J, Piccirillo JF. Psychometric and Clinimetric Validity of the Modified 25-Item Sino-Nasal Outcome Test. American journal of rhinology & allergy. 2019;33(5):577-85.
91. 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(1):41-7.

92. Pynnonen MA, Kim HM, Terrell JE. Validation of the Sino-Nasal Outcome Test 20 (SNOT-20) domains in nonsurgical patients. American journal of rhinology & allergy. 2009;23(1):40-5.
93. 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(5):950-7.
94. Katle EJ, Hart H, Kjaergaard T, Kvaloy JT, Steinsvag SK. Nose- and sinus-related quality of life and GERD. Eur Arch Otorhinolaryngol. 2012;269(1):121-5.
95. Moxness MHS, Bugten V, Thorstensen WM, Nordgard S. Sinonasal Characteristics in Patients with Obstructive Sleep Apnea Compared to Healthy Controls. Int J Otolaryngol. 2017;2017:1935284.
96. Eskeland O, Danielsen KA, Dahl F, Fridrich K, Orszagh VC, Bachmann-Harildstad G, et al. Causes of higher symptomatic airway load in patients with chronic rhinosinusitis. BMC Ear Nose Throat Disord. 2017;17:15.
97. 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(5):736-41.
98. Grant S, Aitchison T, Henderson E, Christie J, Zare S, McMurray J, 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(5):1208-17.
99. Bousquet PJ, Combescure C, Neukirch F, Klossek JM, Mechin H, Daures JP, et al. Visual analog scales can assess the severity of rhinitis graded according to ARIA guidelines. Allergy. 2007;62(4):367-72.
100. Fayers PM, Machin, David. Quality of life (second edition). The assessment, analysis and interpretation of patient-reported outcomes. Second ed. England: John Wiley and Sons Ltd; 2007.
101. Maruish MEE. User`s manual for the SF-36v2 Health Survey: QualityMetric; 2011.
102. Norman GR, Sloan JA, Wyrwich KW. Interpretation of changes in health-related quality of life: the remarkable universality of half a standard deviation. Med Care. 2003;41(5):582-92.
103. Guyatt GH, Osoba D, Wu AW, Wyrwich KW, Norman GR. Methods to explain the clinical significance of health status measures. Mayo Clin Proc. 2002;77(4):371-83.
104. Andre RF, Vuyk HD, Ahmed A, Graamans K, Nolst Trenite GJ. Correlation between subjective and objective evaluation of the nasal airway. A systematic review of the highest level of evidence. Clin Otolaryngol. 2009;34(6):518-25.
105. Szucs E, Clement PA. Acoustic rhinometry and rhinomanometry in the evaluation of nasal patency of patients with nasal septal deviation. Am J Rhinol. 1998;12(5):345-52.
106. Hilberg O, Jackson AC, Swift DL, Pedersen OF. Acoustic rhinometry: evaluation of nasal cavity geometry by acoustic reflection. Journal of applied physiology (Bethesda, Md : 1985). 1989;66(1):295-303.
107. Bermuller C, Kirsche H, Rettinger G, Riechelmann H. Diagnostic accuracy of peak nasal inspiratory flow and rhinomanometry in functional rhinosurgery. Laryngoscope. 2008;118(4):605-10.

108. Ottaviano G, Fokkens WJ. Measurements of nasal airflow and patency: a critical review with emphasis on the use of peak nasal inspiratory flow in daily practice. Allergy. 2016;71(2):162-74.

109. Arts DG, De Keizer NF, Scheffer GJ. Defining and improving data quality in medical registries: a literature review, case study, and generic framework. J Am Med Inform Assoc. 2002;9(6):600-11.

110. Registre NSfM. 2019 [Available from: https://www.kvalitetsregistre.no/.

111. Solomon DJ, Henry RC, Hogan JG, Van Amburg GH, Taylor J. Evaluation and implementation of public health registries. Public Health Rep. 1991;106(2):142-50.

112. Varmdal T, Bakken IJ, Janszky I, Wethal T, Ellekjaer H, Rohweder G, et al. Comparison of the validity of stroke diagnoses in a medical quality register and an administrative health register. Scandinavian journal of public health. 2016;44(2):143-9.

113. Illum P. Septoplasty and compensatory inferior turbinate hypertrophy: long-term results after randomized turbinoplasty. Eur Arch Otorhinolaryngol. 1997;254 Suppl 1:S89-92.

114. Rimmer J, Fokkens W, Chong LY, Hopkins C. Surgical versus medical interventions for chronic rhinosinusitis with nasal polyps. The Cochrane database of systematic reviews. 2014;12:Cd006991.

115. Acevedo JL, Camacho M, Brietzke SE. Radiofrequency Ablation Turbinoplasty versus Microdebrider-Assisted Turbinoplasty: A Systematic Review and Meta-analysis. Otolaryngol Head Neck Surg. 2015;153(6):951-6.

116. Akduman D, Yanilmaz M, Haksever M, Doner F, Sayar Z. Patients` evaluation for the surgical management of nasal obstruction. Rhinology. 2013;51(4):361-7.

117. Karlsson TR, Shakeel M, Supriya M, Ram B, Ah-See KW. Septoplasty with concomitant inferior turbinate reduction reduces the need for revision procedure. Rhinology. 2015;53(1):59-65.

118. Devseren NO, Ecevit MC, Erdag TK, Ceryan K. A randomized clinical study: outcome of submucous resection of compensatory inferior turbinate during septoplasty. Rhinology. 2011;49(1):53-7.

119. Harrill WC, Pillsbury HC, 3rd, McGuirt WF, Stewart MG. Radiofrequency turbinate reduction: a NOSE evaluation. Laryngoscope. 2007;117(11):1912-9.

120. Schwentner I, Dejakum K, Schmutzhard J, Deibl M, Sprinzl GM. Does nasal septal surgery improve quality of life? Acta Otolaryngol. 2006;126(7):752-7.

121. Stewart MG, Smith TL, Weaver EM, Witsell DL, Yueh B, Hannley MT, et al. Outcomes after nasal septoplasty: results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. Otolaryngol Head Neck Surg. 2004;130(3):283-90.

122. Arunachalam PS, Kitcher E, Gray J, Wilson JA. Nasal septal surgery: evaluation of symptomatic and general health outcomes. Clin Otolaryngol Allied Sci. 2001;26(5):367-70.

123. Coste A, Yona L, Blumen M, Louis B, Zerah F, Rugina M, et al. Radiofrequency is a safe and effective treatment of turbinate hypertrophy. Laryngoscope. 2001;111(5):894-9.

124. Siegel NS, Gliklich RE, Taghizadeh F, Chang Y. Outcomes of septoplasty. Otolaryngol Head Neck Surg. 2000;122(2):228-32.

125. Pirila T, Tikanto J. Unilateral and bilateral effects of nasal septum surgery demonstrated with acoustic rhinometry, rhinomanometry, and subjective assessment. Am J Rhinol. 2001;15(2):127-33.
126. 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(8):1779-84.
127. Katotomichelakis M, Simopoulos E, Tripsianis G, Balatsouras D, Danielides G, Kourousis C, et al. Predictors of quality of life outcomes in chronic rhinosinusitis after sinus surgery. Eur Arch Otorhinolaryngol. 2014;271(4):733-41.
128. 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(4):246-51.e2.
129. Smith TL, Litvack JR, Hwang PH, Loehrl TA, Mace JC, Fong KJ, et al. Determinants of outcomes of sinus surgery: a multi-institutional prospective cohort study. Otolaryngol Head Neck Surg. 2010;142(1):55-63.
130. Hopkins C, Slack R, Lund V, Brown P, Copley L, Browne J. Long-term outcomes from the English national comparative audit of surgery for nasal polyposis and chronic rhinosinusitis. Laryngoscope. 2009;119(12):2459-65.
131. Deal RT, Kountakis SE. Significance of nasal polyps in chronic rhinosinusitis: symptoms and surgical outcomes. Laryngoscope. 2004;114(11):1932-5.
132. Chester AC, Sindwani R, Smith TL, Bhattacharyya N. Systematic review of change in bodily pain after sinus surgery. Otolaryngol Head Neck Surg. 2008;139(6):759-65.
133. 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(2):207-13.
134. 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(12):2199-205.
135. Hilberg O, Pedersen OF. Acoustic rhinometry: recommendations for technical specifications and standard operating procedures. Rhinol Suppl. 2000;16:3-17.
136. Grymer LF, Illum P, Hilberg O. Septoplasty and compensatory inferior turbinate hypertrophy: a randomized study evaluated by acoustic rhinometry. J Laryngol Otol. 1993;107(5):413-7.
137. Clement PA, Gordts F. Consensus report on acoustic rhinometry and rhinomanometry. Rhinology. 2005;43(3):169-79.
138. Timperley D, Srubisky A, Stow N, Marcells GN, Harvey RJ. Minimal clinically important differences in nasal peak inspiratory flow. Rhinology. 2011;49(1):37-40.
139. Sprangers MA, Schwartz CE. Integrating response shift into health-related quality of life research: a theoretical model. Soc Sci Med. 1999;48(11):1507-15.
140. Rapkin BD, Schwartz CE. Advancing quality-of-life research by deepening our understanding of response shift: a unifying theory of appraisal. Qual Life Res. 2019;28(10):2623-30.
141. Schwartz CE, Sprangers MA. Methodological approaches for assessing response shift in longitudinal health-related quality-of-life research. Soc Sci Med. 1999;48(11):1531-48.
142. Benson K, Hartz AJ. A comparison of observational studies and randomized, controlled trials. N Engl J Med. 2000;342(25):1878-86.

143. Reber M, Rahm F, Monnier P. The role of acoustic rhinometry in the pre- and postoperative evaluation of surgery for nasal obstruction. Rhinology. 1998;36(4):184-7.
144. Taft C, Karlsson J, Sullivan M. Do SF-36 summary component scores accurately summarize subscale scores? Qual Life Res. 2001;10(5):395-404.
145. Ference EH, Tan BK, Hulse KE, Chandra RK, Smith SB, Kern RC, et al. Commentary on gender differences in prevalence, treatment, and quality of life of patients with chronic rhinosinusitis. Allergy & rhinology (Providence, RI). 2015;6(2):82-8.
146. Baumann I, Blumenstock G, Zalaman IM, Praetorius M, Klingmann C, Sittel C, et al. Impact of gender, age, and comorbidities on quality of life in patients with chronic rhinosinusitis. Rhinology. 2007;45(4):268-72.
147. Moxness MH, Bugten V, Thorstensen WM, Nordgard S, Bruskeland G. A comparison of minimal cross sectional areas, nasal volumes and peak nasal inspiratory flow between patients with obstructive sleep apnea and healthy controls. Rhinology. 2016;54(4):342-7.
148. Ottaviano G, Scadding GK, Coles S, Lund VJ. Peak nasal inspiratory flow; normal range in adult population. Rhinology. 2006;44(1):32-5.
149. Ragab SM, Lund VJ, Scadding G. Evaluation of the medical and surgical treatment of chronic rhinosinusitis: a prospective, randomised, controlled trial. Laryngoscope. 2004;114(5):923-30.
150. Chester AC, Antisdel JL, Sindwani R. Symptom-specific outcomes of endoscopic sinus surgery: a systematic review. Otolaryngol Head Neck Surg. 2009;140(5):633-9.
151. Erskine S, Hopkins C, Kumar N, Wilson J, Clark A, Robertson A, et al. A cross sectional analysis of a case-control study about quality of life in CRS in the UK; a comparison between CRS subtypes. Rhinology. 2016;54(4):311-5.
152. Krokstad S, Westin S. Health inequalities by socioeconomic status among men in the Nord-Trondelag Health Study, Norway. Scandinavian journal of public health. 2002;30(2):113-24.
153. Loge JH, Kaasa S. Short form 36 (SF-36) health survey: normative data from the general Norwegian population. Scand J Soc Med. 1998;26(4):250-8.

Supplementary table 1.

Proportions of patients in study 1 with MID in subjective measures after surgery

MID	Septoplasty N=57	Septoplasty + RFIT N=56	RFIT only N=58
Improvement VAS ≥ 30 mm:			
SNO	35 (61%)	40 (71%)	26 (45%)
Nasal discharge	18 (32%)	17 (30%)	14 (24%)
Sneezing	12 (21%)	12 (21%)	7 (12%)
Snoring	25 (44%)	20 (36%)	13 (22%)
Oral breathing	34 (60%)	33 (59%)	18 (31%)
Reduced GH	27 (47%)	27 (48%)	22 (38%)
Improvement SNOT-20 ≥ 0.8 points	24 (42%)	27 (48%)	16 (28%)
Improvement SF-36 ≥ 10 points:			
PF	16 (28%)	17 (30%)	15 (26%)
RP	22 (39%)	27 (48%)	22 (39%)
BP	25 (44%)	22 (39%)	18 (31%)
GH	22 (39%)	20 (36%)	25 (43%)
VT	17 (30%)	24 (43%)	27 (47%)
SF	21 (37%)	21 (38%)	24 (41%)
RE	12 (21%)	15 (27%)	9 (16%)
MH	11 (19%)	10 (18%)	12 (21%)

Presented in numbers and percent. MID: minimal important difference, RFIT: radiofrequency therapy of inferior turbinate, SNO: subjective nasal obstruction, reduced GH: reduced general health, PF: physical function, RP: role physical, BP: bodily pain, GH: general health, VT: vitality, SF: social function, RE: role emotional, MH: mental health

Supplementary table 2.

Proportions of patients in study 2 with: MCA ≤ 0.4 cm^2 before and after surgery and proportions of patients with PNIF ≥ 20 l/min after surgery

	Septoplasty N=50	Septoplasty + RFIT N=51	RFIT only N=47
Pre MCA1 narrow side ≤ 0.4cm^2	37 (74%)	41 (80%)	25 (53%)
Post MCA1 narrow side ≤ 0.4 cm^2	17 (34%)	27 (53%)	16 (34%)
Improvement PNIF ≥ 20 l/min (MID)	28 (56%)	29 (57%)	33 (70%)

Presented in numbers and percent. Pre: preoperatively; post: postoperatively; MCA: minimal cross-sectional area, MID: minimal important difference, PNIF: peak nasal inspiratory flow, RFIT: radiofrequency therapy of the inferior turbinate, MCA1 narrow: minimal cross-sectional area at the most obstructed side preoperatively, pre: preoperatively, post: postoperatively.

Supplementary table 3.

Proportions of patients in study 3 with MID in subjective measures after surgery

MID	CRSwNP N=220	CRSsNP N=196
Improvement VAS ≥ 30 mm:		
SNO	138 (63%)	101 (52%)
Facial pain	59 (27%)	82 (42%)
Sinus pressure	96 (44%)	110 (56%)
Olfaction	105 (48%)	72 (37%)
Nasal discharge	144 (66%)	114 (58%)
Improvement SNOT-20 ≥ 0.8 points	124 (56%)	101 (52%)
Improvement SF-36 ≥ 10 points:		
PF	77 (35%)	86 (44%)
RP	104 (47%)	104 (53%)
BP	109 (50%)	107 (55%)
GH	112 (51%)	75 (38%)
VT	125 (57%)	89 (45%)
SF	125 (57%)	89 (45%)
RE	69 (31%)	60 (31%)
MH	162 (74%)	129 (66%)

Presented in n and percent. MID: minimal important difference, CRSwNP: Chronic rhinosinusitis with nasal polyps, CRSsNP: Chronic rhinosinusitis without nasal polyps, SNO: subjective nasal obstruction, SNOT-20: Sino nasal outcome test, SF-36: Short Form health survey; PF: physical function, RP: role physical, BP: bodily pain, GH: general health, VT: vitality, SF: social function, RE: role emotional, MH: mental health

Errata

Article 1:

The abstract in the result section:

The domain stated in the last part of the first sentence: "…and in the general mental health domain of SF-36" is incorrect. The correct domain should be general health.

The postoperative symptom score (mean with SD) for nasal obstruction in group 1 of 29.1(67.6) is incorrect; it should be corrected to 29.1(26.6).

Table 2: P-values ≤ 0.01 is incorrect, it should be corrected to: p-values < 0.05.

Background section: Reference number 25 (Carr) is incorrect, it should be corrected to reference number 24 (Wallander).

Paper 1

Nilsen et al. BMC Ear, Nose and Throat Disorders (2018) 18:2
DOI 10.1186/s12901-017-0050-z

BMC Ear, Nose and Throat Disorders

RESEARCH ARTICLE Open Access

A comparison of symptoms and quality of life before and after nasal septoplasty and radiofrequency therapy of the inferior turbinate

Ann Helen Nilsen[1*], Anne-Sofie Helvik[1,2], Wenche Moe Thorstensen[1,3] and Vegard Bugten[1,3]

Abstract

Background: The primary goal of this study is to compare pre- and postoperative symptoms and health related quality of life (HQOL) in 57 patients who underwent septoplasty (group-1), 56 patients who underwent septoplasty combined with radiofrequency therapy of inferior turbinates (RFIT) (group-2) and 58 patients who underwent RFIT alone (group-3). The secondary goal is to investigate if the change in symptoms and HQOL differed between these three patient groups after surgery.

Methods: All patients reported symptoms on a visual analogue scale (VAS) and HQOL on Sino-Nasal-Outcome-Test-20 (SNOT-20) and Short-Form-Health-Survey-36 (SF-36) before and 6 months after surgery. The pre- and postoperative scores and improvement were compared within and between the three patient groups.

Results: Preoperatively the three patient groups had a fairly similar symptom burden and HQOL, except for group-1 which reported more symptoms of oral breathing than group-3 *($p < 0.01$)* and group-3 which reported more problems in the ear/facial–subset of SNOT-20 and in the general-mental-health-domain of SF-36 than group-1 *($p < 0.01$)*.
Postoperatively all patient groups reported improved symptom scores of nasal obstruction, nasal discharge, snoring, oral breathing and reduced general health *($p < 0.01$)*, and better HQOL *($p < 0.05$)*. Patients in group-2 had less symptoms of nasal obstruction than group-3 *($p < 0.05$)*. Postoperative symptom score for nasal obstruction was 29.1 (SD67.6) in group-1, 27.5 (SD22.5) in group-2 and 37.2 (SD24.8) in group-3. Revision cases reported more nasal obstruction postoperatively; 41.3 (SD27) than non revision cases; 28.6 (SD24) *($p < 0.01$)*.
The HQOL after surgery was about the same in all three patient groups, but we found that patients with comorbidities as sleep apnea and asthma reported worse HQOL than other patients *($p < 0.01$)*.

Conclusion: Surgical treatment of nasal obstruction led to less symptoms and better HQOL for all three patient groups. Comparing the postoperative scores between the patient groups we find that all groups reached the same level of HQOL. Regarding symptoms, the patients who underwent septoplasty combined with RFIT reported postoperatively less nasal obstruction than patients who underwent RFIT alone which may indicate that a combined procedure of septoplasty and RFIT is better than RFIT alone to treat nasal obstruction. Furthermore, revision cases, patients with sleep apnea and asthma patients seem to have poorer outcome after surgery than other patients. Both disease specific and general QOL instruments add valuable information for identifying factors influencing outcome.

Keywords: Nasal obstruction, Surgery, Health related quality of life, Septum deviation, Inferior turbinate hypertrophy

* Correspondence: ann.helen.nilsen@stolav.no
[1]Department of Ear, Nose and Throat, Head and Neck Surgery, St Olavs University Hospital, 7006 Trondheim, Norway
Full list of author information is available at the end of the article

Background

Patients with symptoms of nasal obstruction frequently consult an otorhinolaryngologist [1]. Nasal obstruction negatively affects patients' quality of life (QOL) [1–3]. Sustained nasal obstruction may have anatomical or structural causes such as deviation of the nasal septum or inferior turbinate hypertrophy (ITH) [4], but chronic diseases such as chronic rhinosinusitis (CRS) and allergic rhinitis (AR) [5, 6] also cause nasal congestion and reduced nasal airflow.

Nasal septal deviation has a prevalence ranging from 19% to 65% due to different definition criteria [7, 8]. Characteristic symptoms of a deviated septum can be nasal obstruction, nasal discharge, sneezing, snoring, oral breathing, and sleep apnea [9]. Some patients with a deviated septum have troublesome symptoms that lead to surgery.

ITH can cause nasal airway obstruction and affects 10–20% of Europe's adult population [10]. ITH can occur in isolation or in combination with deviation of the septum. Normally, patients are treated medically with anti-histamines, topical decongestants and corticosteroids; surgery is reserved for refractory cases [11, 12]. During the last decade, radiofrequency therapy of the ITH (RFIT) has been performed more frequently in combination with septoplasty [1] or as a single approach to reduce nasal obstruction in patients with ITH [13–15]. Various surgery techniques have been used to reduce ITH, but radiofrequency coblation and microdebrider-assisted turbinoplasty are common methods because they are easy to perform [12, 16]. In the literature, there is no clear consensus on the optimal surgical method, optimal selection of patients or expected improvement in symptoms [16–20].

Even if objective measures regularly are being used assessing nasal patency [21], QOL measures are an important guide for measuring the efficacy of surgical interventions, and have thus been used with increasing frequency in recent years within several sino-nasal disorders [11, 22, 23]. There are a large numbers of definitions of QOL. Health related quality of life (HQOL) is the most frequently used approach in epidemiological and clinical health research [24]. HQOL captures aspects of an individual's subjective experience of QOL related to health, disease, disability and impairment and the effects of medical treatment [25]. HQOL is subjective and a multidimensional construct [24] and highlight also the social and psychological consequences of diseases, as the health-care interventions aim to improve [26].

Contradictory results have been reported from studies depending on whether they studied improvement in symptoms or HQOL in patients undergoing surgery for chronic nasal obstruction [9, 14, 27, 28]. To our knowledge, we have not found studies comparing these three differernt diagnosistic groups, and few studies have used both Sino-Nasal OutcomeTest-20 (SNOT-20) and the Short- Form Health Survey 36 (SF-36) to explore whether sino-nasal aspects and more general aspects of HQOL have improved in patients undergoing septoplasty and RFIT [27]. In daily practice it is a challenge tailoring the right patients for the optimal surgery. Patients with clinical significant septal deviation, clinical septal deviation combined with ITH or ITH without significant clinical septum deviation present with the same cardinal symptom; nasal obstruction. There is little evidensbased knowledge guiding the surgeon in decision making. Selection of optimal surgery is based on each surgeons clinical assessment. Assessing the symptom- and HQOL score of the patients may help the surgeons to decide optimal treatment.

The primary aim of this prospective registry-based outcome study was to compare symptoms and HQOL before and after surgery in three patient groups; those who underwent septoplasty alone, septoplasty combined with RFIT and RFIT alone. The secondary aim was to investigate if the change in symptoms and HQOL differed between these three patient groups after surgery.

Material and methods

Ethics, consent and permissions

This prospective registry study was conducted during the period from January 2012 to April 2015 and was approved by the Committee for Medical Research Ethics in Norway, 2015–367/REK NORD. All patients signed a written consent prior to inclusion in the study.

Materials

All patients were referred from general practitioners, private otorhinolaryngologists, or local hospitals in the region to assessment for surgical treatment at the ENT department at St Olavs University Hospital. All patients were examined at the outpatient clinic by a varity of surgeons.

Diagnosis was based on anterior rhinoscopy and nasal endoscopy combined with patients` symptoms. Nasal decongestants was not used in the diagnostic. The diagnoses were based on the International Classification of Diseases (ICD-10) codes J34.2 (septum deviation) and J34.3 (ITH). When there was indication for septoplasty alone, septoplasty in combination with RFIT or only RFIT the patients were asked to participate in the study.

Inclusion criteria were a deviated septum, a deviated septum in combination with ITH or ITH alone without clinical significant septum deviation with presenting symptoms of chronic nasal obstruction, symptoms lasting at least three months and persistent symptoms after medical management.

Exclusion criteria were age less than 18 years, difficulty in interpreting the questionnaires due to language or

cognitive problems, pregnancy, ongoing cancer treatment, granulomatosis with polyangiitis, cystic fibrosis, Kartagener syndrome, sarcoidosis or ciliar dyskinesia.

We included 210 patients. Due to dropouts before surgery (20 patients) and loss of follow-up (17 patients), the total sample of this study was 171 patients, where 57 patients underwent traditional cartilage-preserving septoplasty alone, 56 patients underwent a combination of septoplasty and RFIT, and 58 patients underwent RFIT alone (Fig. 1).

Methods

Symptoms and HQOL

The patients' symptoms were indicated on 100 mm visual analog scales (VAS) where 0 mm represents no symptoms and 100 mm represents symptoms "as troublesome as possible". Symptoms reported were nasal obstruction, nasal discharge, sneezing, snoring, oral breathing and reduced general health [29]. The symptom severity is considered mild between 0 and 30, moderate from 30 to 70 and severe from 70 to 100 [30].

The Sino-Nasal Outcome Test-20 (SNOT-20) questionnaire was used to assess HQOL more specifically related to the sino-nasal outcome. It has been validated in patients with chronic rhinosinusitis [31, 32], and used to assess sino-nasal outcome in relation to other diseases such as asthma [33], cystic fibrosis [34], skull base tumors [35] and in healthy individuals [33].

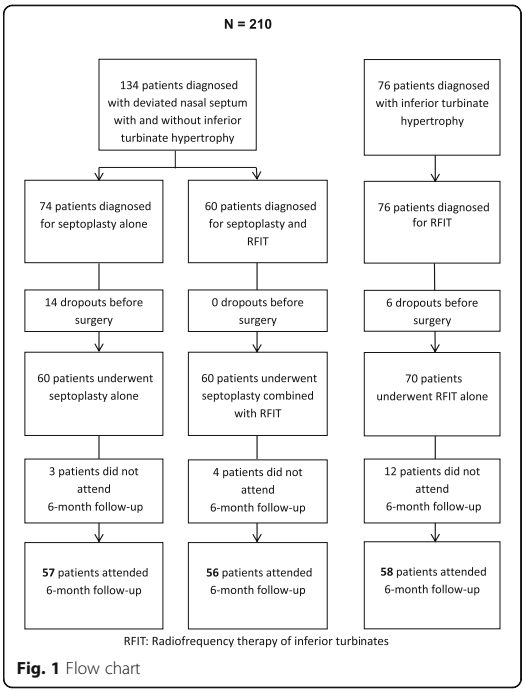

Fig. 1 Flow chart

The patients graded 20 items on a scale from 0 (no problem) to 5 (problem as severe can be). The total SNOT sum score for each patient was defined as the mean value of the response to the 20 items. The questionnaire is divided into four subsets [23]. The first subset is related to the nose issues, the second subset to ear and face issues, the third subset to sleep quality and the fourth subset to psychological issues. Questions about cough and waking up tired are separate entities and do not belong to any subset. A mean score was calculated for each of the subsets.

More general aspects of HQOL were assessed with the Norwegian validated version of the Short-Form-Health-Survey 36 (SF-36) [36–38]. SF-36 can be used to compare HQOL profiles for groups differing in diagnosis, disease severity or treatment regimen and monitor transitions in health status over time for diverse groups [37]. It containes 36 questions belonging to eight domains of HQOL; physical function, restriction in physical role, restriction in emotional role, vitality, social function, bodily pain, mental general health. The eight domain respective scales are gathered in two summary scales, divided into physical and mental health.

Statistics

We used PASW Statistics, version 23 for Windows (SPSS Inc. Chicago, Illinois) for statistical analysis. The mean value ± SD was used to describe symptoms and HQOL. Categorical and ordinal variables were analyzed with the Pearson chi-square test or Fisher exact test depending on sample size. All data regarding symptoms and HQOL at baseline and follow-up were not normally distributed. For comparative analyses of continuous variables we used the Mann-Whitney and Wilcoxon signed ranked test. *P*-values less than 0.05 were considered statistically significant. Power calculations showed that with 40 patients in each group and a significance level of 0.05 (alpha), we were able to detect a difference in SNOT-20 of 0.6 (SD1.2) between the groups with 80% power. With 100 participants in each group and the same assumptions as above, we would be able to detect a difference in SNOT-20 of 0.4.

Results

The baseline characteristics of the patients who underwent septoplasty (group 1), septoplasty with RFIT (group 2) or RFIT alone (group 3) did not differ in demographic or medical characteristics except for more men in group 1 than in group 3 *($p < 0.01$)* (Table 1).

Table 1 Demographic and medical characteristics at baseline

	Total $N = 171$	Group 1 $N = 57$	Group 2 $N = 56$	Group 3 $N = 58$
Mean age, years	38,6 (13,7)	36,5 (14,0)	40,5 (14,4)	38,9 (12,7)
Mean BMI, kg/m^2	27,2 (4,63)	26,3 (4,47)	27,9 (4,68)	27,5 (4,70)
Sex (m/f)	127/44	48/9	43/13	36/22
Smoke daily	18	3	7	8
Allergy	71	26	22	23
Asthma	25	7	9	9
Sleep apnea	38	9	16	13
Previous surgery	38	12	11	15

Abbreviations: Group 1, septoplasty; Group 2, septoplasty combined with radiofrequency therapy of inferior turbinate (RFIT); Group 3, RFIT only; BMI, body mass index. Revision cases: patients having prior surgery of septoplasty, septoplasty combined with RFIT or RFIT alone

Surgical procedures and postoperative care

Patient group 1: The mean duration of surgery in the 57 patients who underwent traditional cartilage-preserving septoplasty alone was 71 min (SD 28). Of these patients, 11 patients had local anesthesia, 46 patients had a silastic plate bilaterally for support and to prevent adhesions postoperatively and 36 patients had a nasal packing to prevent bleeding and hematoma of the septum for 2 days.

Patient group 2: The mean duration of surgery in the 56 patients who had a combination of septoplasty and RFIT was 73 min (SD 32). Of these patients, 44 patients had a silastic plate bilaterally postoperatively and 44 patients had a nasal packing for 2 days. Septoplasty combined with RFIT was performed under general anesthesia with the CelonProBreath® bipolar coagulation electrode (Celon AG medical instruments 2003 Rheinstrasse 8, D-14513 Teltow/Berlin, Germany). The power setting was 15 watts and exposure time ranged from 5 to 15 s with varying applications in each turbinate.

Patient group 3: For the 58 patients who underwent RFIT alone, the mean duration of surgery was 13 min (SD 7) and 57/58 had surgery under local anesthesia. RFIT was done with the Sutter system BM-780 II (Sutter medizintechnik GMBH Tullastrasse 87, 79,108 Freiburg, Germany) AutoRF setting, power adjustment 2; exposure time ranged from 5 to 9 s in each application. The number of applications in each turbinate was assessed by the surgeon.

No treatment allocation, randomization or other attempt to modify treatment was made. The procedures were performed by 14 different surgeons: six consultants and eight senior registrars at St Olavs Hospital. The nasal packing was removed by a nurse in the outpatient clinic or by the patients themselves; the plates were taken out by the surgeon 1 week after surgery. The 6 months follow up was done at the outpatient clinic. The patients filled out the questionnaires alone and handed them to a trained nurse.

Symptoms on VAS before and after surgery

Preoperatively the symptom scores on VAS were fairly similar. Group 3 reported less symptoms of oral breathing than patients in group 1 ($p < 0.01$) (Table 3). Nasal obstruction was the most bothersome preoperative symptom in all three groups.

Six months after surgery all patient groups had significant improvement of all symptoms, except for sneezing in group 3. Patients in group 1 and 2 had significantly greater improvement in symptoms than patients in group 3 ($p < 0.04$, $p < 0.01$), especially for the symptom of nasal obstruction ($p < 0.04$) (Table 3). The improvement in nasal obstruction was 40.5 (SD34) mm for group 1, 44.6 (SD26) mm for group 2 and 29.5 (SD32) mm for group 3.

Postoperatively patients in group 3 reported significantly more symptoms of snoring ($p < 0.03$) than group 1. Group 3 reported more symptoms of nasal obstruction ($p < 0.04$) and sneezing ($p < 0.02$) than group 2. The symptom score for nasal obstruction was 29.1 (SD27.0) mm in group 1, 27.5 (SD22.5) mm in group 2 and 37.2 (SD24.8)mm in group 3 (Table 2 and Fig. 2).

HQOL reported on SNOT-20 and SF-36 before and after surgery

Preoperatively the total SNOT-20 score showed no significant differences between the patient groups, but when we analyzed the subsets in SNOT-20 we found that the patients in group 3 reported worse problems in the ear/facial subset than the patients in group 1 *($p < 0.02$)* (Table 2).

After surgery the total SNOT-20 score and all subset scores improved for all three patient groups (Table 2 and Fig. 3). Patients in group 1 had greater improvement in the sleep function subset than patients in group 3 *($p < 0.05$)*. The patients in group 2 had greater improvement in the total SNOT-20 score ($p < 0.01$) and in the sleep function- and psycologic subset compared to patients in group 3 *($p < 0.04$)* (Table 3).

Comparing the postoperative scores between patient groups we found no significant differences in total SNOT-20 score, but group 2 had less problems in the ear/facial subset than group 3 (Table 2).

The preoperative SF-36 summary scores, i.e. physical and mental health, between the patient groups were not significantly different (Table 2). When we analyzed the different domains of SF-36 we found that the patients in group 1 reported less problems in their general health than group 3 *($p < 0.03$).* Patients in group 2 reported more problems in their emotional role and worse general mental health than patients in group 3 *($p < 0.05$)*.

After surgery the SF-36 summary scores of physical and mental health (Table 2) improved for all three patient groups *($p < 0.05$)* (Table 2 and Fig. 4). Patients in

Table 2 Symptoms and HQOL preoperatively and 6 months postoperatively

	Group 1 Pre N = 57	Group 1 Post N = 57	p	Group 2 Pre N = 56	Group 2 Post N = 56	p	Group 3 Pre N = 58	Group 3 Post N = 58	p
Symptoms - VAS									
Nasal obstruction	70.4(21.9)	29.1 (26.6)	*0.01*	71.8 (16.4)	27.5 (22.5)	*0.01*	66.8 (23.6)	37.2 (24.8)	*0.01*
Nasal discharge	40.6 (31.9)	20.5 (25.4)	*0.01*	39.8 (32.1)	24.2 (28.0)	*0.01*	42.0 (33.6)	29.5 (30.0)	*0.02*
Sneezing	32.2 (28.7)	18.6 (23.4)	*0.01*	27.8 (25.3)	13.2 (19.6)	*0.01*	26.4 (2540)	20.9 (20.9)	*0.18*
Snoring	50.3 (36.2)	22.2 (27.6)	*0.01*	53.2 (32.0)	27.4 (26.8)	*0.01*	45.8 (36.3)	32.7 (30.0)	*0.01*
Oral breathing	67.2 (28.5)	26.3 (29.7)	*0.01*	58.7 (30.8)	22.7 (25.9)	*0.01*	51.9 (31.9)	31.9 (30.5)	*0.01*
Reduced general health	47.7 (33.8)	14.1 (22.0)	*0.01*	43.4 (28.9)	13.0 (20.5)	*0.01*	40.4 (31.5)	18.4 (23.2)	*0.01*
HQOL - SNOT - 20									
Total SNOT 20	1.58 (0.78)	0.97 (0.80)	*0.01*	1.70 (0.84)	0.93 (0.71)	*0.01*	1.59 (0.83)	1.15 (0.87)	*0.01*
Subset:									
Rhinologic	1.83 (0.97)	1.18 (0.82)	*0.01*	1.82 (1.05)	1.17 (0.85)	*0.01*	1.84 (0.94)	1.44 (1.06)	*0.01*
Ear/facial	0.75 (0.75)	0.47 (0.67)	*0.01*	1.05 (0.91)	0.50 (0.58)	*0.01*	1.10 (0.86)	0.79 (0.92)	*0.01*
Sleep	2.25 (1.33)	1.33 (1.28)	*0.01*	2.23 (1.31)	1.15 (1.20)	*0.01*	2.01 (1.46)	1.43 (1.38)	*0.01*
Psychological	1.45 (1.16)	0.82 (1.10)	*0.01*	1.68 (1.07)	0.81 (0.93)	*0.01*	1.39 (1.04)	0.90 (1.03)	*0.01*
HQOL - SF- 36									
PF physical functioning	89.5 (9.89)	91.6 (12.3)	*0.02*	83.6 (15.2)	88.1 (19.3)	*0.01*	84.5 (16.9)	87.7 (18.9)	*0.14*
RP role-physical	68.3 (22.2)	75.2 (20.5)	*0.01*	61.6 (28.8)	71.2 (24.4)	*0.01*	69.3 (22.3)	72.2 (25.0)	*0.26*
BP bodily pain	71.5 (26.0)	76.9 (26.1)	*0.03*	66.0 (30.2)	71.8 (29.0)	*0.13*	68.5 (26.7)	72.7 (26.3)	*0.35*
GH general health	69.7 (21.3)	73.6 (23.8)	*0.07*	62.4 (22.5)	67.4 (23.8)	*0.02*	59.5 (23.1)	64.6 (23.5)	*0.03*
VT vitality	48.7 (19.4)	53.8 (18.5)	*0.02*	44.4 (15.6)	52.1 (16.0)	*0.01*	46.1 (18.4)	54.3 (19.8)	*0.01*
SF social functioning	80.5 (23.3)	86.2 (20.8)	*0.01*	76.8 (23.9)	80.4 (23.9)	*0.20*	80.2 (23.0)	85.6 (21.4)	*0.09*
RE role-emotional	85.7 (20.8)	90.8 (16.9)	*0.08*	81.8 (25.1)	84.3 (24.0)	*0.16*	91.4 (15.5)	91.4 (18.3)	*0.55*
MH general mental health	69.2 (12.9)	70.9 (14.4)	*0.20*	66.6 (11.3)	69.1 (12.0)	*0.04*	70.6 (10.3)	72.1 (11.0)	*0.18*
Physical health summary	74.9 (15.2)	79.3 (17.3)	*0.01*	68.5 (20.4)	74.6 (20.9)	*0.01*	70.5 (17.0)	74.3 (19.8)	*0.05*
Mental health summary	71.5 (16.7)	76.4 (17.3)	*0.01*	66.7 (17.2)	71.0 (18.4)	*0.01*	69.3 (15.1)	74.0 (17.1)	*0.01*

Abbreviations: Group 1, septoplasty; Group 2, septoplasty combined with radiofrequency therapy of inferior turbinate (RFIT); Group 3, RFIT only; VAS, Visual Analog Scale; SNOT-20, Sino-Nasal-Outcome-Test-20; SF-36, Short-Form-Health-Survey-36; pre, preoperative; post, postoperative. Data are presented in mean with standard deviation, *p*-values ≤ 0.01 are considered significant

group 1 and 2 had improvement in five domains of SF-36 *($p < 0.04$)*, while patients in group 3 had improvement in two domains of SF-36 *($p < 0.03$)*. The improvement was not significantly different between the patient groups (Table 3).

Comparing the postoperative scores between patient groups we found no significant differences in the postoperative SF-36 summary scores of physical and mental health. Patients in group 1 reported better score than group 3 in the general health domain *($p < 0.03$)*, while patients in group 2 reported more trouble in the role-emotional domain than patients in group 3 *($p < 0.05$)* (Table 2).

Comorbidity, previous surgery and smoking

In this study some of the patients have comorbidity such as allergy, asthma and sleep apnea and a history of previous septal or turbinate surgery. There were no significant differences in the distribution of these conditions in the groups. Subanalysis showed no difference in nasal obstruction pre- and postoperative on VAS in patients with comorbidity compared to patients without ($p > 0.05$). Patients with previous septal or ITH surgery had less improvement of nasal obstruction*($p < 0.03$)* and were more bothered postoperatively with nasal obstruction *($p < 0.01$)* than patients who had no previous surgery *($p < 0.01$)*. Regarding HQOL we found that patients with allergy preoperatively reported a worse total SNOT-20 score than patients without allergy *($p < 0.03$)*. Postoperatively we found no differences. Sleep apnea patients reported a worse postoperative total SNOT-20 score than patients without sleep apnea *($p < 0.01$)*. Patients with asthma reported worse postoperative summary scores of physical and mental health of SF-36

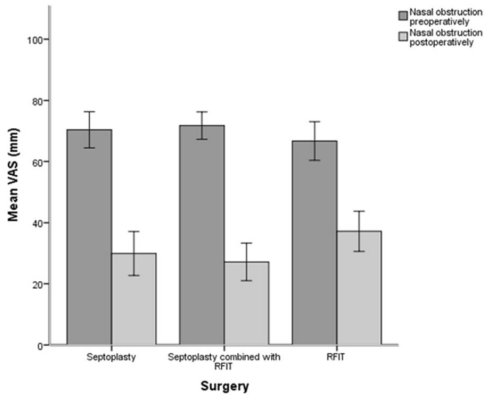

Fig. 2 Nasal obstruction preoperatively and 6 months postoperatively. Values presented as mean, 95% CI

than patients without asthma*($p < 0.01$).* The only statistical difference regarding smoking was that smokers had worse HQOL preoperatively than non-smokers *($p < 0.03$).*

Discussion

In this study the patients undergoing septoplasty (patient group 1), septoplasty combined with RFIT (patient group 2), and RFIT alone (patient group 3) had a fairly similar symptom burden and HQOL preoperatively. All three patient groups had a significant improvement in symptoms and HQOL after surgery (Table 2). When comparing the postoperative scores between the patient groups we find that the mean level of most of the HQOL variables were at the same level in the groups. Regarding symptoms postoperatively, the patients in group 3 reported significantly more trouble with snoring than group 1, and more trouble with nasal obstruction and sneezing than the patients in group 2 (Table 3).

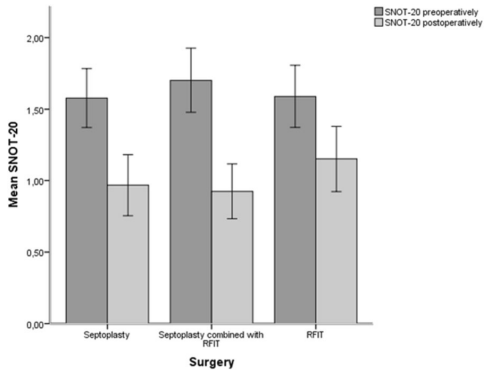

Fig. 3 SNOT- 20 preoperatively and 6 months postoperatively. Values presented as mean, 95% CI

Although the preoperative symptoms between patient groups were fairly similar, we note that the improvement in symptoms was significantly better for the patients in group 1 and 2 than for the patients in group 3.

We found that the patients in group 2 had an improvement in nasal obstruction of 44.6 mm on VAS, while patients in group 1 and 3 had a improvement of 40.5 and 29.5 mm respectively. Rhee et al. consider a change of 30 mm on VAS clinically meaningful [39]. Thus, based on that criterion, all three patients groups had symptom improvements that could be considered a surgical success.

According to severity of symptoms, the symptom of nasal obstruction in the two septoplasty groups changed from severe to mild symptoms after surgery (Table 2). The nasal obstruction in patient group 3 improved significantly, but were also after surgery considered to be moderate bothersome [30].

In spite of the fact that all patients report a similar symptom burden preoperatively we find that group 3 report more bothersome symptoms postoperatively than the other groups. An explanation for this could be that some of the patients in group 3 had a deviated nasal septum that was not considered clinically significant and therefore septoplasty was not done. Another explanation could be that RFIT is not as efficient in opening the nose as septoplasty or a combination of septoplasty and RFIT is. Karlsson et al. showed that concomitant inferior turbinate reduction may decrease the likelihood of revision nasal surgery [40].

The SNOT-20 was used to assess HQOL spesifically related to the sino-nasal aspects. Preoperatively we found no significant differences in the total SNOT-20 score between the patient groups (Table 2).

When we analyzed the subsets in SNOT-20 we noted that patients in group 3 reported more problems in the ear/facial of SNOT-20 than the patients in group 1. An explanation for this difference might be that more oedema of the nasal mucosa and posterior part of the inferior turbinate in the ITH patients influence on the ventilation of the ears and thus lead to more ear fullness or ear pain.

We see that our patients preoperatively report a similar total SNOT-20 score as patients with chronic rhinosinusitis, who report a total SNOT-20 score of 1.9 [31], and a worse score than healthy individuals, who report a mean SNOT-20 score of 0.4 [33]. Surgery led to an improvement in total SNOT-20 score including all subsets for all patient groups (Table 2). The improvement in total SNOT-20 score was significantly better for patients in group 2 than for patients

Table 3 Improvement in symptoms and HQOL 6 months postoperatively

	Improvement Group 1	Improvement Group 2	Improvement Group 3	Comparing 1 vs 2 *p*	Comparing 1 vs 3 *p*	Comparing 2 vs 3 *p*
Symptoms - VAS						
Nasal obstruction	40,5 (33.5)	44.6 (25.7)	29.5 (31.5)	0,39	*0,04*	*0,01*
Nasal discharge	19.3 (30.5)	17.4 (29.5)	12.0 (33.9)	0,86	0,15	0,20
Sneezing	12.9 (32.4)	14.4 (26.6)	5.48 (20.7)	0,40	0,14	*0,01*
Snoring	27.7 (35.0)	26.0 (28.0)	12.9 (28.3)	0,55	*0,01*	*0,01*
Oral breathing	40.1 (35.4)	37.2 (32.3)	19.9 (29.4)	0,50	*0,01*	*0,01*
Reduced general health	33.2 (33.5)	32.0 (29.1)	22.0 (32.7)	0,99	0,06	0,06
HQOL - SNOT- 20						
Total SNOT 20	0.61 (0.68)	0.78 (0.84)	0.44 (0.72)	0,30	0,15	*0,01*
Subset						
Rhinologic	0.66 (1.08)	0.65 (1.09)	0.40 (0.90)	0,95	0,28	0,11
Ear/facial	0.28 (0.62)	0.55 (0.84)	0.32 (0.88)	0,06	0,42	0,32
Sleep	0.92 (1.18)	1.08 (1.36)	0.59 (1.33)	0,82	*0,05*	*0,03*
Psychological	0.63 (0.97)	0.87 (1.01)	0.50 (1.00)	0,12	0,63	*0,04*
HQOL - SF-36						
PF physical functioning	2.17 (10.3)	4.42 (15.7)	3.17 (20.2)	*0,69*	*0,65*	*0,41*
RP role-physical	6.86 (19.9)	9.55 (24.8)	2.91 (21.2)	*0,57*	*0,48*	*0,22*
BP bodily pain	5.42 (22.8)	5.82 (27.0)	3.74 (22.5)	*0,71*	*0,38*	*0,66*
GH general health	4.49 (18.8)	5.14 (15.7)	5.10 (16.4)	*0,99*	*0,84*	*0,77*
VT vitality	5.00 (16.0)	8.00 (16.3)	8.25 (16.8)	*0,35*	*0,37*	*0,99*
SF social functioning	5.70 (18.5)	3.57 (18.9)	5.39 (24.0)	*0,66*	*0,76*	*0,50*
RE role-emotional	5.12 (20.2)	2.46 (21.8)	0.00 (19.7)	*0,64*	*0,85*	*0,43*
MH general mental health	1.96 (9.94)	2.54 (8.69)	1.43 (11.0)	*0,61*	*0,89*	*0,74*
Physical health summary	4.44 (12.9)	6.08 (16.1)	3.80 (14.0)	*0,74*	*0,59*	*0,59*
Mental health summary	4.91 (12.9)	4.33 (12.1)	4.69 (14.6)	*0,83*	*0,94*	*0,93*

Abbreviations: Group 1, septoplasty; Group 2, septoplasty combined with radiofrequency therapy of inferior turbinate (RFIT); Group 3, RFIT only; VAS, Visual Analog Scale; SNOT-20, Sino-Nasal-Outcome-Test-20; SF-36, Short-Form-Health-Survey-36; pre, preoperative; pos, postoperative. Data are presented in mean with standard deviation, p-values ≤ 0.01 are considered significant

in group 3. Regarding the subsets of SNOT-20, we found that both septoplasty groups had larger improvement in the sleep subset than group 3 (Table 3), so it is likely to believe that the larger improvement in nasal obstruction in these groups led to greater improvement in the sino-nasal aspects of HQOL.

Our findings in SNOT-20 were similar to those of other studies using SNOT-22 or other HQOL assessments of sino-nasal outcome [9, 41, 42].

Patients in group 2 had a mean improvement in the total SNOT-20 score of 0.8, while the other groups had an improvement of 0.4 and 0.6. According to Piccirillo, a change in total score of 0.8 in SNOT-20 is clinically meaningful for patients with CRS after surgery [31]. Thus, only the patients in group 2 achieved a clinically meaningful change in SNOT-20. This indicate that a combination of septoplasty and RFIT is meaningful because it seem to improve the sino-nasal aspects of HQOL more than septoplasy alone and RFIT alone. This may have implications for what kind of surgery to choose for our patients in the future.

Nevertheless, also patients in group 3 had postoperatively improved their total SNOT-20 score, and the three patient groups ended up having quite a similar total SNOT-20 score after surgery (Table 2). Therefore RFIT alone might be considered wise in patients with ITH where the nasal deviation is not clinical significant. RFIT is considered to be a safe and well tolerated procedure preserving the nasal epithelial function, with little postoperative pain, bleeding and crusting. It is a rapid procedure that can be performed under local anesthesia, allowing the patient to return to work or home immediately after treatment [43].

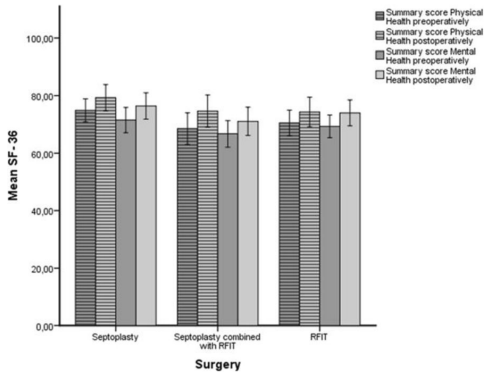

Fig. 4 SF- 36 preoperatively and 6 months postoperatively. Values presented as mean, 95% CI

SF-36 was used to assess more general aspects of the patients HQOL. Preoperatively the patient groups reported a similar physical and mental health according to the summary scores of SF-36, but some of the eight domains differed slightly (Table 2).

Preoperatively the patients in group 1 reported better score in the general health domain than group 3, and patients in group 2 reported worse score in the emotional role- and general mental health domain than group 3. Thus indicating that patients with a clinically significant septal deviation combined with ITH may have worse general HQOL than patients with ITH without a clinical significant septum deviation.

After surgery all patient groups improved their physical and mental health according to the summary scores, but the improvement within domains differed between the patient groups (Table 2). Patients in group 1 had improvement in five domains; physical functioning, role-physical, bodily pain, vitality and social functioning. Patients in group 2 had improvement in five domains; physical functioning, role- physical, general health, vitality and general mental health. Patients in group 3 had impovement in the general health and vitality domain. This may indicate that the patients in group 1 and 2 had greater improvement in general HQOL than patients in group 3.

The improvement in some domains may partly be influenced by the worse preoperatively outset. Further more there could be a ceiling effect in the questionnaire indicating that patients in group 3, who had extreme high scores preoperatively in the emotional role domain, could not respond with even more extreme high scores.

In spite of these influences, our results also imply that septoplasty and septoplasty combined with RFIT improved the general HQOL more than only RFIT. Our findings in improvement in general aspects of HQOL after septoplasty is supported by others [42], but not by all [9, 41].

We found that all patient groups reported similar general HQOL postoperatively, except for patients in group 1 who reported better HQOL in the general health domain than group 3 like they did preoperatively, and that the patients in group 2 reported worse HQOL in the role- emotional domain postoperatively than group 3 as they did preoperatively. This might indicate that all three surgical procedures influence these two aspects of SF-36 equally.

None of our groups of patients reached the same level in general aspects of HQOL as healthy people [44]., Our sub-analysis showed that patients with allergy report worse HQOL on SNOT-20 before surgery than non-allergic patients. After surgery we found no differences. Nevertheless, treatment of allergy is important also after surgery. The patients with sleep apnea reported postoperatively worse HQOL in SNOT-20 score than patients without sleep apnea *($p < 0.01$).* The same results were found for the asthma patients regarding postoperative summary scores of physical and mental health in SF-36 *($p < 0.01$),* thus more or other treatment [45] than nasal surgery should be considered for these patients. Patients with previous surgery were more bothered with nasal obstruction after surgery ($p < 0.01$) which may indicate that surgery in these patients is more challenging.

The major strength of this study is the prospective design and the high follow-up rate (81%). This study has some limitations. We did not randomize the patients to treatment groups. We wanted this study to reflect the daily practice in an out patient clinic. We used the SNOT-20 to evaluate sino-nasal quality of life because we did not have a validated translation of the SNOT-22 questionnaire at the onset of the study. SNOT-20 lack questions about nasal obstruction and sense of smell in the first subset, the three other subsets are equal with SNOT-22. We have compensated for this by evaluating the nasal obstruction on VAS which we know have a strong correlation to nasal resistance [46]. However, the lack of postoperative difference in SNOT-20 between patient groups may be caused by the lack of question about nasal obstruction. Using SNOT-22 may have led to a slightly different outcome regarding HQOL.

We used two different devices for RFIT and one could argue that this might influence our results. The Celon ProBreath® was used in the patients in group 2 and the Sutter system BM-780 II was used on all patients in the group 3. A review comparing different surgical techniques for bilateral ITH reduction reported no significant difference in nasal obstruction using either microdebrider-assisted turbinoplasty or multiple types of radiofrequency devices [16].

Conclusion

We have shown that surgical treatment of nasal obstruction leads to less symptoms and better HQOL for all three patient groups. Patients treated with septoplasty alone or septoplasty combined with RFIT achieved a better improvement in symptoms, and patients treated with septoplasty combined with RFIT also achieved a better improvement in HQOL than patients treated with only RFIT. Nevertheless, comparing the postoperative scores we find that all patient groups reach about the same level of HQOL. Regarding symptoms, the patients in group 2 reported less nasal obstruction postoperatively than patients in group 3 which may indicate that a combined procedure of septoplasty and RFIT is better than RFIT alone to treat nasal obstruction. Furthermore, revision cases, patients with sleep apnea and asthma patients seem to have poorer outcome after surgery than other patients. Both disease specific and general QOL instruments add valuable information for identifying factors influencing outcome.

Additional file

Additional file 1: Spreadsheet that include information from the patients about symptoms given on VASs and HQOL given on SNOT-20 and SF-36. (XLS 306 kb)

Additional file 2: Response letter. (DOCX 18 kb)

Abbreviations

HQOL: Health related quality of life; ITH: Inferior turbinate hypertrophy; RFIT: Radiofrequency therapy of inferior turbinate; SD: Standard deviation; SF-36: Short-form-health-survey-36; SNOT-20: Sino-nasal-outcome-test-20; VAS: Visual analogue scale

Acknowledgments

We thank the chief of the ENT department Mette Bratt and study nurses Else Bartnes, Tove Helen Midtlyng and collegues in the outpatient clinic. A special thank to senior engieneer Berit M. Bjelkåsen at Unit for Applied Clinical Research, NTNU for assisting the data management.

Funding

Organizations were the department of Ear, Nose and Throat, Head and Neck Surgery, St. Olavs University Hospital, Trondheim, Norway, and Department of Neuroscience, Norwegian University of Science and Technology, Norway.

Availability of data and materials

The data supporting our findings are attached as spreadsheets in the Additional file 1. The author response letter is included here as Additional file 2. If additional questions, please contact the corresponding author.

Authors' contributions

AHN and VB designed the study and AHN drafted the first version of the manuscript. All authors (AHN, VB, ASH, WMT) contributed in conception and design, acquisition of data, analysis and interpretation of data, writing, and drafting the article, revising it critically for important intellectual content. All authors read and approved the final manuscript.

Authors' information

Ann Helen Nilsen is a research nurse and a PhD-candidate.
Vegard Bugten is an otolaryngologist and associate professor.
Anne-Sofie Helvik is a RN and a researcher.
Wenche Moe Thorstensen is an otolaryngologist and associate professor.

Ethics approval and consent to participate

The study is approved by the Committee for Medical Research Ethics in Norway, 2015/367/REK NORD. All patients and controls signed a written consent prior to inclusion in the trial.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

Author details

[1]Department of Ear, Nose and Throat, Head and Neck Surgery, St Olavs University Hospital, 7006 Trondheim, Norway. [2]Institute of Public Health and General Practice, Norwegian University of Science and Technology, 7006 Trondheim, Norway. [3]Department of Neuromedicine and Movement Science, Norwegian University of Science and Technology, 7006 Trondheim, Norway.

Received: 1 February 2017 Accepted: 22 December 2017
Published online: 26 January 2018

References

1. Han JK, Stringer SP, Rosenfeld RM, Archer SM, Baker DP, Brown SM, Edelstein DR, Gray ST, Lian TS, Ross EJ, et al. Clinical consensus statement: septoplasty with or without inferior turbinate reduction. Otolaryngology Head Neck Surgery. 2015;153(5):708–20.
2. Baumann I. Quality of life before and after septoplasty and rhinoplasty. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2010;9:Doc06.
3. Shedden A. Impact of nasal congestion on quality of life and work productivity in allergic rhinitis: findings from a large online survey. Treat Respir Med. 2005;4(6):439–46.
4. Nurse LA, Duncavage JA. Surgery of the inferior and middle turbinates. Otolaryngol Clin N Am. 2009;42(2):295–309. ix
5. Hastan D, Fokkens WJ, Bachert C, Newson RB, Bislimovska J, Bockelbrink A, Bousquet PJ, Brozek G, Bruno A, Dahlen SE, et al. Chronic rhinosinusitis in Europe–an underestimated disease. A GA(2)LEN study. Allergy. 2011;66(9):1216–23.
6. Bauchau V, Durham SR. Prevalence and rate of diagnosis of allergic rhinitis in Europe. Eur Respir J. 2004;24(5):758–64.
7. Smith KD, Edwards PC, Saini TS, Norton NS. The prevalence of concha bullosa and nasal septal deviation and their relationship to maxillary sinusitis by volumetric tomography. Int J Dent. 2010;2010(404982):5. https://doi.org/10.1155/2010/404982.
8. Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. AJNR Am J Neuroradiol. 2004;25(9):1613–8.
9. Hytonen ML, Lilja M, Makitie AA, Sintonen H, Roine RP. Does septoplasty enhance the quality of life in patients? Eur Arch Otorhinolaryngol. 2012;269(12):2497–503.
10. Seeger J, Zenev E, Gundlach P, Stein T, Muller G. Bipolar radiofrequency-induced thermotherapy of turbinate hypertrophy: pilot study and 20 months' follow-up. Laryngoscope. 2003;113(1):130–5.
11. Batra PS, Seiden AM, Smith TL. Surgical management of adult inferior turbinate hypertrophy: a systematic review of the evidence. Laryngoscope. 2009;119(9):1819–27.
12. Cingi C, Ure B, Cakli H, Ozudogru E. Microdebrider-assisted versus radiofrequency-assisted inferior turbinoplasty: a prospective study with objective and subjective outcome measures. Acta Otorhinolaryngol Ital. 2010;30(3):138–43.
13. Devseren NO, Ecevit MC, Erdag TK, Ceryan K. A randomized clinical study: outcome of submucous resection of compensatory inferior turbinate during septoplasty. Rhinology. 2011;49(1):53–7.
14. Stewart MG, Smith TL, Weaver EM, Witsell DL, Yueh B, Hannley MT, Johnson JT. Outcomes after nasal septoplasty: results from the nasal obstruction septoplasty effectiveness (NOSE) study. Otolaryngol Head Neck Surg. 2004;130(3):283–90.

15. Jose J, Coatesworth AP. Inferior turbinate surgery for nasal obstruction in allergic rhinitis after failed medical treatment. Cochrane Database Syst Rev. 2010;12:Cd005235.
16. Acevedo JL, Camacho M, Brietzke SE. Radiofrequency ablation Turbinoplasty versus Microdebrider-assisted Turbinoplasty: a systematic review and meta-analysis. Otolaryngol Head Neck Surg. 2015;153(6):951–6.
17. Clement WA, White PS. Trends in turbinate surgery literature: a 35-year review. Clinical otolaryngology and allied sciences. 2001;26(2):124–8.
18. Ye T, Zhou B. Update on surgical management of adult inferior turbinate hypertrophy. Curr Opin Otolaryngol Head Neck Surg. 2015;23(1):29–33.
19. Brunworth J, Holmes J, Sindwani R. Inferior turbinate hypertrophy: review and graduated approach to surgical management. Am J Rhinol Allergy. 2013;27(5):411–5.
20. Harrill WC, Pillsbury HC 3rd, McGuirt WF, Stewart MG. Radiofrequency turbinate reduction: a NOSE evaluation. Laryngoscope. 2007;117(11):1912–9.
21. Holmstrom M. The use of objective measures in selecting patients for septal surgery. Rhinology. 2010;48(4):387–93.
22. Stewart MG, Witsell DL, Smith TL, Weaver EM, Yueh B, Hannley MT. Development and validation of the nasal obstruction symptom evaluation (NOSE) scale. Otolaryngol Head Neck Surg. 2004;130(2):157–63.
23. 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(5):736–41.
24. Wallander JL, Koot HM. Quality of life in children: a critical examination of concepts, approaches, issues, and future directions. Clin Psychol Rev. 2016; 45:131–43.
25. Carr AJ, Gibson B, Robinson PG. Measuring quality of life: is quality of life determined by expectations or experience? BMJ. 2001;322(7296):1240–3.
26. Gliklich RE, Hilinski JM. Longitudinal sensitivity of generic and specific health measures in chronic sinusitis. Qual Life Res. 1995;4(1):27–32.
27. Croy I, Hummel T, Pade A, Pade J. Quality of life following nasal surgery. Laryngoscope. 2010;120(4):826–31.
28. Enache A, Lieder A, Issing W. Nasal septoplasty with submucosal diathermy to inferior turbinates improves symptoms at 3 months postoperatively in a study of one hundred and one patients. Clin Otolaryngol. 2014;39(1):57–63.
29. Grant S, Aitchison T, Henderson E, Christie J, Zare S, McMurray J, Dargie H. 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(5):1208–17.
30. Fokkens WJ, Lund VJ, Mullol J, Bachert C, Alobid I, Baroody F, Cohen N, Cervin A, Douglas R, Gevaert P, et al. EPOS 2012: European position paper on rhinosinusitis and nasal polyps 2012. A summary for otorhinolaryngologists. Rhinology. 2012;50(1):1–12.
31. 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(1):41–7.
32. Pynnonen MA, Kim HM, Terrell JE. Validation of the Sino-nasal outcome test 20 (SNOT-20) domains in nonsurgical patients. Am J Rhinol Allergy. 2009; 23(1):40–5.
33. 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(5):950–7.
34. Willis J, Michael DD, Boyer H, Misono S. Prevalence and severity of dysphonia in patients with cystic fibrosis: a pilot study. Otolaryngol Head Neck Surg. 2015;153(1):88–93.
35. Derousseau T, Manjunath L, Harrow B, Zhang S, Batra PS. Long-term changes in quality of life after endoscopic resection of sinonasal and skull-base tumors. Int Forum Allergy Rhinol. 2015;5(12):1129–35.
36. Ware JE Jr. SF-36 health survey update. Spine (Phila Pa 1976). 2000;25(24): 3130–9.
37. 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(6):473–83.
38. Loge JH, Kaasa S, Hjermstad MJ, Kvien TK. Translation and performance of the Norwegian SF-36 health survey in patients with rheumatoid arthritis. I. Data quality, scaling assumptions, reliability, and construct validity. J Clin Epidemiol. 1998;51(11):1069–76.
39. Rhee JS, Sullivan CD, Frank DO, Kimbell JS, Garcia GJ. A systematic review of patient-reported nasal obstruction scores: defining normative and symptomatic ranges in surgical patients. JAMA Facial Plast Surg. 2014;16(3): 219–25. quiz 232
40. Karlsson TR, Shakeel M, Supriya M, Ram B, Ah-See KW. Septoplasty with concomitant inferior turbinate reduction reduces the need for revision procedure. Rhinology. 2015;53(1):59–65.
41. Arunachalam PS, Kitcher E, Gray J, Wilson JA. Nasal septal surgery: evaluation of symptomatic and general health outcomes. Clin Otolaryngol Allied Sci. 2001;26(5):367–70.
42. Schwentner I, Dejakum K, Schmutzhard J, Deibl M, Sprinzl GM. Does nasal septal surgery improve quality of life? Acta Otolaryngol. 2006;126(7):752–7.
43. Coste A, Yona L, Blumen M, Louis B, Zerah F, Rugina M, Peynegre R, Harf A, Escudier E. Radiofrequency is a safe and effective treatment of turbinate hypertrophy. Laryngoscope. 2001;111(5):894–9.
44. Loge JH, Kaasa S. Short form 36 (SF-36) health survey: normative data from the general Norwegian population. Scand J Soc Med. 1998;26(4):250–8.
45. Doff MH, Hoekema A, Wijkstra PJ, van der Hoeven JH, Huddleston Slater JJ, de Bont LG, Stegenga B. Oral appliance versus continuous positive airway pressure in obstructive sleep apnea syndrome: a 2-year follow-up. Sleep. 2013;36(9):1289–96.
46. Ciprandi G, Mora F, Cassano M, Gallina AM, Mora R. Visual analog scale (VAS) and nasal obstruction in persistent allergic rhinitis. Otolaryngology Head Neck Surgery. 2009;141(4):527–9.

Paper 2

Paper 2: Nilsen, Ann Helen; Thorstensen, Wenche Moe; Helvik, Anne-Sofie; Nordgård, Ståle; Bugten, Vegard. Improvement in minimal cross-sectional area and nasal-cavity volume occurs in different areas after septoplasty and radiofrequency therapy of inferior turbinates. European Archives of Oto-Rhino-Laryngology 2018 ;Volum 275. (8) s. 1995-2003

Paper 3

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.

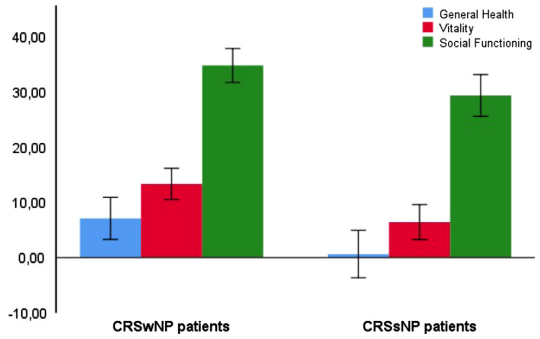

Fig. 1. Improvement in general health, vitality, and social functioning 6 months after surgery. Presented with mean values and 95% confidence interval of SF-36 domains. CRSsNP = chronic rhinosinusitis patients without nasal polyps; CRSwNP = chronic rhinosinusitis patients with nasal polyp.

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.

Appendix

St. Olavs Hospital HF
Universitetssykehuset i Trondheim
ØNH- poliklinikk, telefon: 72 57 61 31

HELSE MIDT-NORGE

Forespørsel om deltakelse i Kvalitetsregisteret ved nese- bihule- seksjonen ved ØNH – avdelingen ved St Olavs Hospital

Bakgrunn:
ØNH- avdelingen ved St Olavs Hospital har opprettet et kvalitetsregister for pasienter med nese og bihule- plager. Det er ønskelig at de som har behandlet deg (leger og andre helsearbeidere) får kjennskap til sine behandlingsresultater. De kan da vurdere effekten av behandlingen de tilbyr på en systematisk måte. Hensikten med registeret er å forbedre kvaliteten på behandlingen som blir tilbudt ved sykehuset.

Hva skal registreres?
De opplysningene som inngår i registeret er ditt personnummer og navn, opplysning om diagnose, samt opplysninger som beskriver plagene dine, livskvalitet og yrkesstatus. I tillegg registreres vanlige journalopplysninger som sykehistorie, røntgenfunn og opplysninger knyttet til behandlingen, samt resultatene fra undersøkelser i forbindelse med kontroller. Vi ønsker også at du gir tilbakemelding på hvor tilfreds du er med behandlingen. Denne tilfredshetsundersøkelsen er en del av kvalitetsregisteret. Svarene du gir blir avidentifisert og vil ikke være knyttet til deg i etterkant av behandlingen.

Hvordan samles opplysningene inn?
Opplysningene samles inn både før, under og etter operasjonen. Før operasjonen registreres spørreskjemaene som vi nå ber deg fylle ut, samt opplysninger fra leger og sykepleiere som behandler deg. Opplysninger fra undersøkelser i forbindelse med kontrollen etter operasjonen vil også bli registrert og du vil bli bedt om og fylle ut de samme skjemaene ved etterkontrollen som du gjorde før operasjonen.

Mulige fordeler og ulemper:
Opplysningene som registreres vil kunne hjelpe oss å sikre kvaliteten på behandlingen vi tilbyr våre pasienter. Du vil ikke ha noen spesielle fordeler av deltakelse i registeret.

Hva skjer med informasjonen om deg?
Det er kun de som har behandlet deg og de ansvarlige for kvalitetsregisteret som får tilgang på dine personidentifiserbare opplysninger. Alle opplysninger om deg vil bli behandlet i samsvar med lover og regler for taushetsplikt.

I eventuelle forskningsprosjekt vil opplysningene om deg bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode vil knytte deg til dine opplysninger gjennom en navneliste. Det er kun autorisert personell knyttet til din behandling som har adgang til navnelisten og kan finne tilbake til deg. Årsaken til at man har en slik koblingsliste, er for å kunne sammenstille data i et framtidig forskningsprosjekt der slik sammenstilling er nødvendig. Det vil ikke være mulig å identifisere deg i resultatene når disse publiseres.
Forskere vil kunne bruke registeret til å evaluere blant annet hva som har betydning for gode eller dårlige operasjonsresultater, hvilken betydning behandlingen har i relasjon til trygde- og sosialmedisinske forhold og i forhold til helseøkonomi.

Dersom opplysninger skal benyttes av andre må de ansvarlige for registret til enhver tid vurdere og gi samtykke til at opplysningene benyttes i samsvar med registerets protokoll og formål. Opplysningene vil bli anonymisert før de eventuelt utleveres.
For spesielle forskningsprosjekter kan det være aktuelt å sammenstille informasjonen med andre offentlige registre (se oversikt på baksiden av dette arket). Dersom du godtar at dine opplysninger kan brukes til forskning, samtykker du også til at du kan kontaktes på nytt utenom ordinær kontroll, eventuelt mange år frem i tid.

De enkelte forskningsprosjektene og eventuelle koblinger til andre registre vil måtte vurderes av Personvernombudet, Regional komité for medisinsk og helsefaglig forskningsetikk (REK) og om nødvendig godkjennes av datatilsynet. Forskningsresultatene kan komme fremtidige pasienter til nytte og vil bli publisert i medisinske tidsskrifter i inn- og utland.

Lagring av data og dine rettigheter
Skjemaene oppbevares i et sikkert og låst arkiv ved sykehuset. De vil bli makulert når opplysningene er kontrollert og overført til en avidentifisert datafil som etterkommer lovverkets krav for å behandle personopplysninger. Opplysninger i databasen lagres på en trygg måte som ivaretar personvernet. De vil bli lagret i flere tiår fremover.

Frivillig deltakelse
Det er frivillig om du vil la deg registrere. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i registeret. Dette vil ikke få konsekvenser for din videre behandling. Selv om du har sagt ja, kan du på ethvert tidspunkt trekke ditt samtykke, og du har rett til å kreve at eventuelle feil blir korrigert eller at opplysninger blir slettet fra databasen.

Det kan være aktuelt å sammenstille informasjon fra kvalitetsregisteret for Kvalitetsregisteret ved nese- bihule- seksjonen ved St. Olavs Hospital med følgende offentlige registre og befolkningsundersøkelser:

- Forløpsdatabasen Trygd (FD- Trygd)
- Dødsårskregisteret
- Medisinsk fødselsregister
- Norsk pasientregister
- Kreftregisteret
- Reseptregisteret
- Registeret i statistisk sentralbyrå
- Befolkningsundersøkelsene som inngår i Conor (Cohort of Norway)
- Befolkningsundersøkelsene som inngikk i statens Helseundersøkelser (SHuS)
- Helseundersøkelsene i Nord-Trøndelag (HUNT)

Det vil også kunne bli aktuelt å sammenstille avidentifiserbare opplysninger fra kvalitetsregisteret ved nese- bihule- seksjonen ved St. Olavs Hospital med tilsvarende opplysninger fra andre sykehus.
Ved alle slike sammenstillinger er det nødvendig med forhåndsgodkjenning av de offentlige instanser loven krever, for eksempel Personvernombudet, Regional komité for medisinsk forskningsetikk, Datatilsynet, Helsedirektoratet eller Rikstrygdeverket.
All informasjon vil bli behandlet med respekt for personvern og privatliv og i samsvar med lover og forskrifter.

Vennlig hilsen ØNH - avdelingen, St Olavs Hospital

Forespørsel om deltakelse i Kvalitetsregisteret ved nese- bihule- seksjonen ved ØNH – avdelingen ved St Olavs Hospital

Samtykkeerklæring

☐ Jeg har lest informasjonen overfor og hatt anledning til å stille spørsmål. Jeg samtykker i at de nevnte opplysningene registreres og gjøres tilgjengelig for den avdeling som har behandlet meg.

☐ Jeg samtykker til at opplysningene kan brukes til forskning på helsehjelp til pasienter med nese- og bihuleplager og søvnproblemer.

Sted:_____ Dato:_____

Underskrift:_____ Tlf:_____

VAS-skalaer i Kvalitetsregister(sykepleier preop) Pasientnr: | | | | | |

Personnummer: | | | | | | | | | | | |

Hvor mange bihulebetennelser har du hatt siste året? | |

Hvor plaget har du vært de siste 2 uker av følgende symptomer. Angi med en strek som krysser linjen hvor plaget du er. Hvor du ligger på linjen bestemmer du.

	Ingen plager — Verst tenkelige plager	ikke skriv her
Nesetetthet		
Hodepine		
Ansiktssmerter		
Press i bihuler		
Endret luktesans		
Sekresjon fra nesen og i svelget		
Nysing		
Bihulebetennelser		
Hoste		
Snorking		
Munnpusting		
Påvirket allmenntilstand		

ingen plager — verst tenkelige plager

SINO-NASAL OUTCOME TEST (preop)

Pasientnr: | | | | | |

Personnr: | | | | | | | | | | | |

Nedenfor finner du en liste over symptomer og sosiale/følelsesmessige konsekvenser av din neselidelse. Vi vil gjerne vite mer om disse problemene, og vil være takknemlig hvis du vil besvare nedenstående spørsmål etter beste evne. Det er ikke noen riktige eller feile svar, og bare du kan gi oss den rette informasjonen. Vær vennlig å gradere dine problemer med utgangspunkt i situasjonen de **siste to uker**. Takk for at du vil delta.

A.
Med utgangspunkt i hvor uttalt problemet er når det oppstår og hvor ofte det opptrer, bes du angi hvor "ille" det er ved at markere med kryss det tallet som best svarer til det du føler, ut fra denne skala

	Ingen problemer	Meget milde problemer	Milde eller lette problemer	Moderate problemer	Kraftige problemer	Problemene er så kraftige som det er mulig
1. behov for å pusse nese	☐	☐	☐	☐	☐	☐
2. nysing	☐	☐	☐	☐	☐	☐
3. rennende nese	☐	☐	☐	☐	☐	☐
4. hoste	☐	☐	☐	☐	☐	☐
5. renning bak i svelget	☐	☐	☐	☐	☐	☐
6. tykt sekret fra nesen	☐	☐	☐	☐	☐	☐
7. tetthet i ørene	☐	☐	☐	☐	☐	☐
8. svimmelhet	☐	☐	☐	☐	☐	☐
9. øresmerter	☐	☐	☐	☐	☐	☐
10. smerter/trykk i ansiktet	☐	☐	☐	☐	☐	☐
11. vanskelig å falle i søvn	☐	☐	☐	☐	☐	☐
12. våkner om natten	☐	☐	☐	☐	☐	☐
13. mangel av god nattesøvn	☐	☐	☐	☐	☐	☐
14. trøtt når du våkner	☐	☐	☐	☐	☐	☐
15. kraftesløshet	☐	☐	☐	☐	☐	☐
16. nedsatt produktivitet	☐	☐	☐	☐	☐	☐
17. nedsatt konsentrasjon	☐	☐	☐	☐	☐	☐
18. frustrert/rastløs/irritabel	☐	☐	☐	☐	☐	☐
19. trist	☐	☐	☐	☐	☐	☐
20. flau	☐	☐	☐	☐	☐	☐

Pasientnr: | | | | | |

B. Vær vennlig å markere de viktigste punktene som påvirker din helsetilstand (maksimum 5 punkter)

- ☐ 1. behov for å pusse nese
- ☐ 2. nysing
- ☐ 3. rennende nese
- ☐ 4. hoste
- ☐ 5. renning bak i svelget
- ☐ 6. tykt sekret fra nesen
- ☐ 7. tetthet i ørene
- ☐ 8. svimmelhet
- ☐ 9. øresmerter
- ☐ 10. smerter/trykk i ansiktet
- ☐ 11. vanskelig å falle i søvn
- ☐ 12. våkner om natten
- ☐ 13. mangel av god nattesøvn
- ☐ 14. trøtt når du våkner
- ☐ 15. kraftesløshet
- ☐ 16. nedsatt produktivitet
- ☐ 17. nedsatt konsentrasjon
- ☐ 18. frustrert/rastløs/irritabel
- ☐ 19. trist
- ☐ 20. flau

Din Helse og Trivsel

Preop

Pasientnr: | | | | | |

Personnummer | | | | | | | | | | | |

INTRODUKSJON: Dette spørreskjemaet handler om hvordan du ser på din egen helse. Disse opplysningene vil hjelpe oss til å få vite hvordan du har det og hvordan du er i stand til å utføre dine daglige gjøremål. Takk for at du fyller ut dette spørreskjemaet.

For hvert av de følgende spørsmålene vennligst sett et (X) i den ene luken som best beskriver ditt svar.

---

1. Stort sett, vil du si at din helse er:

☐ Utmerket ☐ Meget god ☐ God ☐ Nokså god ☐ Dårlig

2. Sammenlignet med for ett år siden, hvordan vil du si at din helse stort sett er nå ?

Mye bedre nå enn for ett år siden	Litt bedre nå enn for ett år siden	Omtrent den samme som for ett år siden	Litt dårligere nå enn for ett år siden	Mye dårligere nå enn for ett år siden
☐	☐	☐	☐	☐

3. De neste spørsmålene handler om aktiviteter som du kanskje utfører i løpet av en vanlig dag. Er din helse slik at den begrenser deg i utførelsen av disse aktivitetene nå? Hvis ja, hvor mye?

	Ja, begrenser meg mye	Ja, begrenser meg litt	Nei, begrenser meg ikke i det hele tatt
a. Anstrengende aktiviteter som å løpe, løfte tunge gjenstander, delta i anstrengende idrett	☐	☐	☐
b. Moderate aktiviteter som å flytte et bord, støvsuge, gå en tur eller drive med hagearbeid	☐	☐	☐
c. Løfte eller bære en handlekurv	☐	☐	☐
d. Gå opp trappen flere etasjer	☐	☐	☐
e. Gå opp trappen en etasje	☐	☐	☐
f. Bøye deg eller sitte på huk	☐	☐	☐
g. Gå mer enn to kilometer	☐	☐	☐
h. Gå noen hundre meter	☐	☐	☐
i. Gå hundre meter	☐	☐	☐
j. Vaske eller kle på deg	☐	☐	☐

Pasientnr: | | | | | |

4. I løpet av de siste 4 ukene, hvor ofte har du hatt noen av de følgende problemer i ditt arbeid eller i andre av dine daglige gjøremål på grunn av din fysiske helse?

	Hele tiden	Mye av tiden	En del av tiden	Litt av tiden	Ikke i det hele tatt
a. Du har måttet redusere tiden du har brukt på arbeid eller på andre gjøremål	☐	☐	☐	☐	☐
b. Du har utrettet mindre enn du hadde ønsket	☐	☐	☐	☐	☐
c. Du har vært hindret i å utføre visse typer arbeid eller gjøremål	☐	☐	☐	☐	☐
d. Du har hatt problemer med å gjennomføre arbeidet eller andre gjøremål (for eksempel fordi det krevde ekstra anstrengelser)	☐	☐	☐	☐	☐

5. I løpet av de 4 siste ukene, hvor ofte har du hatt noen av de følgende problemer i ditt arbeid eller andre av dine daglige gjøremål på grunn av følelsesmessige problemer (som for eksempel å være deprimert eller engstelig)?

	Hele tiden	Mye av tiden	En del av tiden	Litt av tiden	Ikke i det hele tatt
a. Du har måttet redusere tiden du har brukt på arbeid eller på andre gjøremål	☐	☐	☐	☐	☐
b. Du har utrettet mindre enn du hadde ønsket	☐	☐	☐	☐	☐
c. Du har utført arbeidet eller andre gjøremål mindre grundig enn vanlig	☐	☐	☐	☐	☐

6. I løpet av de siste 4 ukene, i hvilken grad har din fysiske helse eller følelsesmessige problemer hatt innvirkning på din vanlige sosiale omgang med familie, venner, naboer eller foreninger?

☐ Ikke i det hele tatt ☐ Litt ☐ En del ☐ Mye ☐ Svært mye

7. Hvor sterke kroppslige smerter har du hatt i løpet av de siste 4 ukene?

☐ Ingen ☐ Meget svake ☐ Svake ☐ Moderate ☐ Sterke ☐ Meget sterke

8. I løpet av de siste 4 ukene, hvor mye har smerter påvirket ditt vanlige arbeid (gjelder både arbeid utenfor hjemmet og husarbeid)?

☐ Ikke i det hele tatt ☐ Litt ☐ En del ☐ Mye ☐ Svært mye

Pasientnr: | | | | | |

9. Disse spørsmålene handler om hvordan du har følt deg og hvordan du har hatt det de siste 4 ukene. For hvert spørsmål, vennligst velg det svaralternativet som best beskriver hvordan du har hatt det. Hvor ofte i løpet av de siste 4 ukene har du:

	Hele tiden	Mye av tiden	En del av tiden	Litt av tiden	Ikke i det hele tatt
a. Følt deg full av liv?	☐	☐	☐	☐	☐
b. Følt deg veldig nervøs?	☐	☐	☐	☐	☐
c. Vært så langt nede at ingenting har kunnet muntre deg opp?	☐	☐	☐	☐	☐
d. Følt deg rolig og harmonisk?	☐	☐	☐	☐	☐
e. Hatt mye overskudd?	☐	☐	☐	☐	☐
f. Følt deg nedfor og deprimert?	☐	☐	☐	☐	☐
g. Følt deg sliten?	☐	☐	☐	☐	☐
h. Følt deg glad?	☐	☐	☐	☐	☐
i. Følt deg trett?	☐	☐	☐	☐	☐

10. I løpet av de siste 4 ukene, hvor ofte har din fysiske helse eller følesesmessige problemer påvirket din sosiale omgang (som det å besøke venner, slektninger osv.)?

☐ Hele tiden ☐ Mye av tiden ☐ En del av tiden ☐ Litt av tiden ☐ Ikke i det hele tatt

11. Hvor RIKTIG eller GALT er hver av de følgende påstander for deg?

	Helt riktig	Delvis riktig	Vet ikke	Delvis gal	Helt gal
a. Det virker som om jeg blir syk litt lettere enn andre	☐	☐	☐	☐	☐
b. Jeg er like frisk som de fleste jeg kjenner	☐	☐	☐	☐	☐
c. Jeg tror at helsen min vil forverres	☐	☐	☐	☐	☐
d. Jeg har utmerket helse	☐	☐	☐	☐	☐

Takk for at du fylte ut dette spørreskjemaet!