INTERNATIONAL JOURNAL OF
ADVANCED SCIENTIFIC RESEARCH AND INNOVATION

PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

Outcome of Endoscopic Frontal Sinus Surgery for Chronic Rhinosinusitis with and without Polyps

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Abstract

Background: Endoscopic frontal sinus surgery (EFSS) for frontal chronic rhinosinusitis (CRS) is performed for patients with frontal CRS failing medical therapy or complicated cases in order to restore normal mucociliary clearance while minimizing trauma to the delicate frontal recess mucosa. Comparison of the results of EFSSin patients with chronic rhinosinusitis with nasal polyp (CRSwNP) versus chronic rhinosinusitis without nasal polyp (CRSsNP) is missed in the literature.

Objectives: to compare the outcome of EFSS in patients with CRS with nasal polyp (CRSwNP) versus CRS without nasal polyp (CRSsNP) by assessing the frontal sinus ostium patency and quality of life of patients as measured by the Sinonasal OutcomeTest-22 (SNOT-22).

Patients and methods: A forty six patient cohort with frontal CRS(22 CRSwNP and 24 CRSsNP) was prospectively evaluated using the SNOT-22, CT imaging, and endoscopic examination. Six months at least post-FESS, patients were reassessed with SNOT-22 and endoscopic assessment for the frontal sinus osteam patency.

INTERNATIONAL JOURNAL OF
ADVANCED SCIENTIFIC RESEARCH AND INNOVATION
PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

Results: Within included 46 patients (22 CRSwNP and 24 CRSsNP) underwent EFSS, a significant improvement ($p < 0.0001$) in the SNOT-22 symptom scores was achieved postoperatively in both patients with CRSwNP and CRSsNP.Inaddition to each of its mean; rhinological, ear and facial, sleep function, psychological, cough, and waking up tired subscale scores were also signifacntly improved in both CRSwNP and CRSsNP. Moreover, the 6 months postoperative examination, revealed 85% overall patent frontal sinus ostia;86.4% in CRSwNP and 83.3% in CRSsNP..

Conclusion: Endoscopic frontal sinus surgery could significantly improve the quality of life of patients with CRS with and without nasal polyps with high frontal sinus ostia patency rate.

Key Words: Endoscopic frontal sinus surgery, frontal sinusitis, SNOT-22, chronic rhinosinusitis, CRSwNP, CRSsNP.

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ADVANCED SCIENTIFIC RESEARCH AND INNOVATION
PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

Introduction

Chronic rhinosinusitis (CRS) is a common disease with a significant impact on the quality of life (QoL) of theaffected patients. Because of its increasing prevalence, CRS is associated with a significant socioeconomic burden**(1, 2)**. In cases of frontal sinusitis, the underlying problem is rarely limited to the frontal sinus itself, but rather its drainage pathway through and around a ethmoidal labyrinth of termed the frontal recess **(3)**.

The frontal sinus is the most challenging paranasal sinus to get good endoscopic surgical results due to complex and varied anatomy, acute angle of access, and proximity to critical structures (anterior ethmoidal artery, olfactory fossa, skull base, and orbit) as well as a liability for post-operative scarring and stenosis **(4)**.

Frontal sinus surgery has evolved from radical, morbid procedures to minimally invasive endoscopic mucosal preserving techniques. There is still argument regarding the most proper surgical approach because multiple endoscopic approaches have been represented and long term effectiveness of these approaches is debated**(3, 4)**.

In an attempt to improve healing and subsequent post-operative results, surgeons today try to preserve the sinuses mucosa by using through-cutting instruments, powered micro debriders, and balloon dilation technology**(5)**.

Clinicians have traditionally focused on objective findings to assess response after treatment; however, in CRS, objective measures might fail to detect the full disease burden felt by the patients**(6)**.Multiple disease specific QoLmeasurements exist for the evaluation of CRS, for example, Rhinosinusitis Disability Index (RSDI) **(7)** and Sinonasal Outcome Test-22 (SNOT-22) **(8)**.

INTERNATIONAL JOURNAL OF
ADVANCED SCIENTIFIC RESEARCH AND INNOVATION
PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

The aim of the present study is to evaluate different techniques and outcomes of endoscopic frontal sinus surgery (EFSS) in management of frontal sinusitis objectively evaluating the patency of the frontal sinus ostium patency by endoscopy and evaluating outcome and effect on OoL as measured by the Sinonasal OutcomeTest-22 (SNOT-22)EFSS.

Patients and methods

A prospective cohort of 46 patients with chronic frontal rhinosinusitis (22 CRSwNP and 24 CRSsNP) who underwent EFSS was performed. The used diagnostic criteria for CRS followed the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS) (68), which includes two or more symptoms, one of which is either nasal blockage/obstruction/congestion or nasal discharge (anterior/posterior nasal drip)± facial pain/pressure ± reduction or loss of smell, in the presence of either endoscopic or CT image evidence of inflammation in the sinuses.

Patients with frontal CRS with or without nasal polyposis not responding to appropriate medical treatment, in the presence of radiological evidence of chronic frontal sinusitis were included in the study.

Patients had sinonasal tumors (benign or malignant), sinonasal granulomatous lesions e.g. granulomatosis with polyangiitis, invasive fungal rhinosinusitis and/or primary mucociliary abnormalities e.g. Kartagner syndrome were excluded from the study.

Preoperative evaluation:

After history taking and examination, all participants filled out the Sinonasal Outcome Test-22 (SNOT-22) **(8)** pre-operatively and at least six months postoperatively, with higher total and subscale scores implying a higher impact of the disease. Diagnostic nasal endoscopy, CT and routine laboratory were done for all patients preoperatively.

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Operative technique:

Thorough review of CT scans in axial, sagittal, and coronal views with creation of a three-dimensional map of the anatomy of paranasal sinuses before surgery, anticipating what would be seen with each move of the endoscope.

Under general anesthesia, patient was positioned in a slight reverse Trendelenburg position, topical placement of topical epinephrine soaked cottonoids and patience were the main facilitators of hemostasis.

Using4 mm Hopkins rod endoscopes at angles of 0, 45, and 70 degrees, endoscopic sinus surgery was performed using standard technique: the uncinate process was resected, middle meatal antrostomy performed, anterior and posterior ethmoidectomy and sphenoidotomy were all done according to the extent of the disease as determined by clinical and radiological findings.

Endoscopic frontal sinus surgery (Draf I, Draf IIA):

The extent of EFSS was determined by reference to the preoperative CT scans and intra operative findings, but typically consisted of Draf I, and Draf IIA. Draf type I frontal sinusotomy consists of removal of the ethmoidal cells obstructing the frontal sinus drainage pathway without altering the frontal sinus ostium. Draf type IIA frontal sinusotomy consists of enlargement of the frontal sinus drainage pathway by resecting the floor of the frontal sinus between the lamina papyracea and middle turbinate. Agger nasi cell was mostly removed first using Kuhn-Bolger curette that was inserted gently behind and above it, and then the cell fractured downward with a technique characterized by Stammberger as “uncapping the egg". Then, the bone was taken down anteriorly and laterally, opening the frontal sinus ostium while respecting the mucociliary flow over the lateral wall of the frontal recess at the plane of the lamina papyracea which is responsible for transporting secretions out of the sinus.

PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

Uncapped terminal recess and frontal recess cells (e.g. suprabullar cell, type 1 and type 3 frontal cells) formed domes that simulated the frontal sinuses. Careful palpation, with a ball probe or Kuhn curette revealed a crevice between the middle turbinate and the uncapped cells. The aim was to open this crevice, which turned out to be the pathway to the frontal recess and the frontal sinus. This was done by passing the ball probe or Kuhn curette above their domes and gently lateralizing them. The bony fragments then were removed with through-cutting punches if attached to mucosa or with giraffe forceps if free of bony attachments. This process was repeated until the frontal sinus ostium was visualized. Frontal sinus seekers were used to retrieve small bony fragments obstructing the ostium or to divide flaps of mucosa to drape them flat along the bony surfaces. The mucosa was preserved especially in the vicinity of the frontal sinus ostium .

Postoperative follow up:

The nasal pack "if present" was removed after 48 hours with suction of any secretions or blood from the nasal cavity and paranasal sinuses. All patients were encouraged to start saline douching after pack removal. Office endoscopic debridement was performed one week post-operatively. Then, the patients were followed up according to the endoscopic findings.

Post-operative assessment was done at least 6 months postoperatively with the SNOT-22 and endoscopic evaluation. The impact of surgery on the SNOT-22 symptom scores was presented as the difference between the pre-operative and postoperative SNOT-22 scores and frontal ostium patency on endoscopic evaluation.

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Statistical analysis:

The Kolmogorov-Smirnov test was used to test assess the differences between preoperative and postoperative scores between CRSwNP vs. CRSsNP patients. Continuous data are displayed as mean± standard deviation.

Results

A total of 46 patients (22 CRSwNP and 24 CRSsNP) underwent EFSS over the 32 months study period, including 18 men, 28 women; age range 16-66 years (mean= 46±17.4).The mean follow up period for all patients was 10.3± 2.6 months, ranging between 6 and 15 months.

The impact of surgery on the SNOT-22 symptom scores was presented as the difference between the pre-operative and postoperative SNOT-22 scores. In CRSwNP, patients had a significant improvement ($p< 0.0001$) in the total mean SNOT-22 score (42.8±18.8 pre-operatively to 18.3±13.8 post-operatively).Inaddition to each of its mean; rhinological, ear and facial, sleep function, psychological, cough, and waking up tired subscale scores from 17± 6.1, 4.6±3.1, 5.9±3.9, 10.9± 6.5, 2.2± 1.1, 2.2± 1.4 preoperatively to 7±4.8, 1.5±1.7, 2.7±2.7, 5.1± 5.3, 0.9+ 0.9, -1.3+ 0.9 postoperatively respectively **(table 1).** In CRSsNP, patients had also a significant improvement ($p<0.0001$) in the total mean SNOT-22 score (45.9± 21.4 pre-operatively to 14.9± 9 post-operatively).Inaddition to each of its mean; rhinological, ear and facial, sleep function, psychological, cough, and waking up tired subscale scores from 15.8± 7.7, 6.1±3.4, 5.7±3.8, 14.3± 7.5, 1.7+ 1.1, 2.3+ 1.5 preoperatively to 5.5± 3.4, 1.7±1.8, 1.9± 1.8, 4.4± 3.1, 0.7± 0.8, 0.7± 0.9 postoperatively respectively (table 1).

INTERNATIONAL JOURNAL OF
ADVANCED SCIENTIFIC RESEARCH AND INNOVATION
PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

Thus, the SNOT-22 total score, as well as its subscale scores, significantly decreased ($p< 0.05$) post-operatively for CRSwNP and CRSsNP patients and the distributions of the improvement in all the SNOT-22 scores from pre-operative to post-operative did not differ significantly between CRSwNP and. CRSsNP groups of patients.

Follow up endoscopic examination at least 6 months postoperatively revealed overall 39/46 (85%) patent frontal sinus ostia;19 out of 22 CRSwNP (86.4%) and 20 out of 24CRSsNP (83.3%) patients without near significant difference between both group ($p= 0.082$).

Table (1): SNOT-22 pre and postoperative mean total, rhinologic, ear and facial, sleep function, psychological, cough, and waking up tired scores for the patients with CRSwNP vs. those with CRSsNP

	Asthmatic (n = 14)				Non-asthmatic (n = 46)			
	Preoperative Mean ± SD	Postoperative Mean ± SD	Postoperative – preoperative score Mean ± SD	W, p	Preoperative Mean ± SD	Postoperative Mean ± SD	Postoperative – preoperative score Mean ± SD	W, p
Total	42.8 ± 18.8	18.3 ± 13.8	-24.5 ± 12.2	W = -4.3, p <0.0001	45.9 ± 21.4	14.9 ± 9	-31 ± 16.4	W = -4.2, p <0.0001
Rhinologic	17 ± 6.1	8 ± 4.8	-9.9 ± 4	W = -4.3, p <0.0001	15.8 ± 7.7	5.5 ± 3.4	-10.3 ± 5.6	W = -4.1, p <0.0001
Ear and facial	4.6 ± 3.1	1.5 ± 1.7	-3.1 ± 2.7	W = -3.8, p <0.0001	6.1 ± 3.4	1.7 ± 1.8	-4.4 ± 2.5	W = -4.2, p <0.0001
Sleep function	5.9 ± 3.9	2.7 ± 2.7	-3.2 ± 2.7	W = -3.8, p <0.0001	5.7 ± 3.8	1.9 ± 1.8	-3.9 ± 3.4	W = -3.8, p <0.0001
Psychological	10.9 ± 6.5	5.1 ± 5.3	-5.8 ± 4.7	W = -4, p <0.0001	14.3 ± 7.5	4.4 ± 3.1	-9.9 ± 6.7	W = -4, p <0.0001
Cough	2.2 ± 1.1	0.9 ± 1	-1.3 ± 1	W = -3.6, p <0.0001	1.7 ± 1.1	0.8 ± 0.8	-1 ± 1.1	W = -3.3, p = 0.001
Waking up tired item	2.2 ± 1.4	0.9 ± 0.9	-1.3 ± 0.9	W = -3.9, p <0.0001	2.3 ± 1.5	0.7 ± 0.9	-1.6 ± 1.3	W = -3.7, p <0.0001

Discussion

Rhinosinusitis is defined as inflammation of the nose and the paranasal sinuses characterized by two or more symptoms, one of which should be either nasal blockage/ obstruction/congestion or nasal discharge (anterior/posterior nasal drip), ±facial pain/pressure, ±reduction or loss of smell; and either endoscopic signs of polyps and/or mucopurulent discharge primarily from middle meatus and/ or edema/mucosal obstruction primarily in middle meatus and/or CT changes reporting mucosal changes within ostiomeatal complex and/or sinuses. CRS symptoms must present for > 12 weeks **(9)**.

PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

Endoscopic sinus surgery for CRS is typically reserved for patients refractory to standard medical treatments (e.g. antibiotic, saline douches, nasal steroid, and/or systemic steroid), patients with fungal rhinosinusitis, or those with complications. Prior studies investigating surgical outcomes for CRS showed significant improvements in the quality of life (QOL)**(6)**.Variability in the individual patient QOL can in part be explained by extent and pathology of CRS **(6)**.

Surgery for the frontal sinus has been evolved from radical open and ablative procedures to minimally invasive endoscopic procedures. Although, the advanced technology and instrumentation has facilitated this progression, the frontal sinus surgery remains the most difficult to master. Functional drainage of the frontal sinus relies on preservation of the frontal recess mucosa. Knowledge of the frontal sinus anatomy is paramount before attempting to surgically treat frontal CRS. An integrated surgical approach is recommended, with escalation of extent of surgery depending on the disease severity, failure of prior procedures and surgeon's preference.

The frontal sinus is the most difficult paranasal sinuses region to achieve good surgical results with a high incidence of restenosis and recurrence after EFSS may be because of; undissected frontal recess cells with residual bony lamellae in the frontal recess, a retained superior portion of the uncinate process (terminal recess mistakenly identified as the frontal sinus), osteoneogenesis, lateralization of the middle turbinate, scarring with circumferential stenosis, mucosal stripping, inflammatory mucosal thickening, and/or recurrent polyps **(3)**.

PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

The comparatively high incidence of osteoneogenesis in post-EFSS patients is believed to be related to surgical mucosal trauma, persistent inflammation, and chronic refractory infection. The presence of osteoneogenesis may contribute to the surgical failure, as it has been supposed that osteitic bone remnants acts as an inflammatory nidus, inducing overlying mucosal edema and hypertrophy, that may predispose to frontal recess and ostium stenosis **(16)**. Thus, it is not related to presence or absence of the nasal polyp.

Our study demonstrated that with optimal surgical management of frontal CRS performed in a manner that preserves mucosa, and allows for complete removal of bony lamellae obstructing the frontal recess and with regular postoperative care including medical management combined with meticulous debridement of crusting and scar tissue, EFSS can achieve a high success rate in both CRSwNP or CRSsNP.

Health related quality of life (HRQoL) questionnaires are diagnostic tools to assess the effect of a disease on daily life and well-being as perceived by the patient'**(32)**. A similar level of symptoms can have a different impact on the HRQoL of different patients, depending on their individual tolerance of this symptom **(33)**.

Physicians often use HRQoL to measure the effects of chronic illness and to better understand how an illness interferes with patient's day to day life and improve patient physician communication and clinical outcome**(34, 35)**.In our study, we utilized the SNOT-22 to prospectively assess the quality of life improvement. This is a validated 22 item survey consisting of rhinological, ear and facial, sleep function, and psychological subscales with total scores ranging between 0–110.

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Higher SNOT-22 total and subscale scores imply greater impact on the quality of life related to the disease **(38)**.The SNOT-22 covers abroad range of health and health related quality of life problems including 'physical problems, functional limitations and emotional consequences' **(39)**.

Surprisingly, there is little prospective literature on the effect of EFSS on quality of life utilizing validated quality of life surveys. Thus, the purpose of our prospective study was to evaluate EFSS on the quality of life utilizing theSNOT-22 and its different subscales with minimum six months follow-up in CRSwNP and CRSsNP.

We chose to have a minimum follow up of 6 months in light of multi-institutional longitudinal study from three medical centers conducted by **Smith and Solar (6)** at 6, 12, and 20 months follow up after endoscopic sinus surgery, they reported that statistically significant improvement was seen at 6 months follow up, while no further statistically significant differences at later time points. As such, they suggested that clinical trial designs incorporating quality of life outcomes after endoscopic sinus surgery should consider the 6 month time frame as an appropriate primary end point.

In our study, the extent of EFSS was determined by reference to the preoperative CT scans and intra operative findings. Significant improvement was also seen in individual items on theSNOT-22. The SNOT-22 total score with its subscale score significantly decreased post-operatively for CRSwNP, and CRSsNP groups of patients with no significant difference between and CRSwNP vs. CRSsNP groups. In addition, patent frontal sinus ostium was achieved in 85% of all patients; 86.4% in CRSwNP and 83.3% in CRSsNP.

PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

In **Askar et al study (40),** of patients with frontal CRS utilizing folley catheter as a tool during surgery to compress the edematous mucosa, reported significant improvement of the quality of life measured by SNOT-22(The mean change score from preoperative to post operative was -34.92), while endoscopic assessment revealed patent frontal sinus Ostia in 89% of cases. While **Chan et al. (3)** reported significant improvement of the quality of life after EFSS by SNOT-20 questionnaire (improved from mean pre-operative score 2.01 to mean post-operative score 1.52) and reported patency rate of 87% but this study was retrospective.

Measurement of the different subscale scores of the SNOT-22 helped us to better understand the impact of CRS on the quality of life, including its physical, functional, and emotional aspects, in addition to allowing better interpretation of the effect of EFSS on these aspects.

In our study, was specifically focused on the frontal sinus, the quality of life. So we recognize that a limitation of our study is that the improvement seen in the quality of life for our patients may have resulted from the endoscopic sinus surgery for all the operated paranasal sinuses not only from the EFSS. However, we have designed our study in a fashion similar to the previous publications, attempting to improve upon them by doing a prospective assessment using validated disease specific tools in combination with endoscopic examination and assess the results in CRSwNP and CRSsNP.

PRINT ISSN 2785-9533 VOLUME 3, ISSUE 1, 2020, 1 – 15. ONLINE ISSN 2785-9541

Conclusion

Endoscopic frontal sinus surgery could significantly improve the quality of life of patients with CRS with and without nasal polyps with high frontal sinus ostia patency rate.

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