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Is frontal pain a useful marker of chronic frontal sinusitis?

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ABSTRACT

Objective: This study evaluates the relationship of frontal pain as a symptom in chronic frontal sinusitis drawing comparisons with radiological and endoscopic findings, quality of life and disease severity. The aim: to determine its utility as a marker in chronic frontal sinusitis and in surgical decision-making.

Methods: Prospective study of 51 consecutive patients undergoing endoscopic sinus surgery for chronic rhinosinusitis. Patients ranked their frontal pain score on a numerical rating scale from 0-10. Facial pain/pressure, SNOT-22, NOSE, Lund-Mackay, and Modified Lund-Kennedy scores were also collated. Statistical analysis: ANOVA and Pearsons correlation coefficient.

Results: Frontal pain scores were low and demonstrated no correlation with the extent of frontal sinus disease radiologically or the severity of overall sinus disease endoscopically. Higher frontal pain scores significantly correlated with poorer quality-of-life.

Conclusion: We do not support the use of frontal pain as a sensitive or specific marker of chronic frontal sinus disease.

MeSH: Frontal Sinusitis, Quality of life, Chronic Disease, Endoscopy, Nasal Surgical Procedures

INTRODUCTION

Endoscopic sinus surgery (ESS) is the treatment of choice in, and improves quality of life (QoL) for, patients with chronic rhinosinusitis (CRS) refractory to medical treatment. The aims of surgery are to improve the QoL in patients, achieve patency of the sinus drainage pathways and reduce inflammation.[1,2]

There is however variation in the surgical management of patients with frontal sinus disease and frontal sinusotomy is not always performed. The classification of frontal sinus surgery was first described by Wolfgang Draf in 1991 and these principles remain largely unchanged today.[3]

Accessing the frontal sinus can be technically challenging due to variable anatomy and the proximity of nearby critical structures such as the orbit, skull-base and olfactory fossa. Furthermore, there are concerns that post-operative scarring may later lead to iatrogenic frontal sinus symptoms. It has been shown endoscopically that following frontal sinus surgery, most patients demonstrate lasting frontal sinus patency and that their quality-of-life is improved.[4] This quality-of-life improvement however has been measured using generic or disease-specific questionnaires (e.g. SNOT-22, the SF-36, NOSE or EQ5D)[5] which target paranasal sinus disease as a whole. It is therefore difficult to isolate the specific symptomatology attributed to the frontal sinus in isolation, especially as it is rare to operate on this sinus alone. Traditionally frontal sinus disease has been considered to be associated with the symptom of frontal pain. Objectively, however, the diagnosis of frontal sinus disease is largely dependent on the radiological findings, as it is usually quite difficult to

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visualise the frontal sinus endoscopically in the outpatient clinic, unless previous surgery has been done making the endoscopic visibility of this difficult area less challenging. But is frontal pain truly a symptom of frontal sinus disease, and is there a correlation between the frontal pain and the objective findings of frontal sinus disease?

This study aims to further understand the presentation of frontal sinus disease with two objectives. Firstly, to explore whether in the context of CRS, there is an association between frontal pain and radiological frontal sinus disease.

Secondly, to determine whether there is a correlation between frontal pain and the degree of severity of CRS. The latter was assessed by objective endoscopic evaluation using the validated modified Lund-Kennedy score[6], as well as by validated QOL questionnaires such as SNOT-22 and NOSE. Additionally, the relationship between the specific frontal pain score and the more generalized facial pain/ pressure score (as elucidated from the SNOT-22 questionnaire) was also evaluated to identify whether frontal pain can occur in isolation or whether it is a component of a generalized facial pain.

MATERIALS AND METHODS

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This observational study analysed prospectively collected patient data of 51 consecutive patients with objective evidence of chronic rhinosinusitis undergoing endoscopic sinus surgery after failing to respond to medical treatment.

The exclusion criteria for the study were:

1- Patients with unilateral sinus disease.

2- Patients with proven non-inflammatory sinus disease.

3- Patients with secondary chronic sinusitis (sinusitis secondary to autoimmune disorders, mucociliary disorders, neoplastic disorders, etc…).

4- Patients with hypoplastic/ aplastic frontal sinuses.

5- Patients presenting with orbital or intracranial complications of sinusitis.

Patients were classified following endoscopic examination into three groups; sin polyps (sP) – no evidence of nasal polys, ethmoid polyps (eP) – limited nasal polyps in ethmoid sinuses but not extending into the nasal cavities, with polyps (wP) – diffuse evidence of nasal polyps in nasal cavities.

All patients were asked to: rank their individual frontal pain score on a numerical rating scale from 0-10 and complete the SNOT 22[7] and NOSE score questionnaires[8]. The facial pain/pressure score from the SNOT 22 was extracted and recorded separately for each patient. A frontal sinus opacification score was calculated using the Lund Mackay scoring system and the modified Lund-Kennedy score was also completed for each patient. A brief explanation of each of these scoring systems is

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outlined below (Table I). Patient demographics were obtained from the medical records.

Statistical analysis

Data were collected using Microsoft Excel 2016 and the statistical analyses performed using Social Science Statistics (https://www.socscistatistics.com) The relationship between different patient groups was calculated using ANOVA and the correlation between the separate scores (frontal pain, facial pain/pressure, NOSE, frontal sinus opacification and Lund-Mackay) were calculated using Pearson's correlation coefficient.

Ethical approval

Ethical approval was deemed not necessary for this study as the questionnaires completed by the patients (SNOT 22 and NOSE), the enquiry about the severity of the patients' symptoms (including frontal pain), the endoscopic and radiological assessment and the surgery performed did not vary from the authors' normal practice when dealing with patients presenting with CRS.

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RESULTS & ANALYSIS

51 patients were included in the study. This included 34 males and 17 females. Age ranged from 15-80 years (mean 50 years, median 48 years). The disease characteristics and frontal pain scores for the participants are summarised in Table II.

Frontal pain scores ranged from 0-8 (mean 2.7, median 3, mode 0) and facial pain/pressure scores ranged from 0-5. A positive correlation was observed between the two. For both parameters, scores were highest in the sP group although this did not reach statistical significance at $p < 0.05$ (ANOVA, frontal pain: $F = 2.65$, $p = 0.08$; facial pain/pressure: $F = 3.15$, $p = 0.05$).

SNOT-22 scores ranged from 8-107 with a mean SNOT-22 score of 50. 12% of participants scored within the 'mild' category and 44% of participants scored within each of 'moderate' and 'severe'[9] (Figure 1.) A weak positive correlation was demonstrated between frontal pain scores and SNOT-22 scores ($R = 0.2996$, $p = 0.04$). This correlation was stronger between pain/pressure scores and SNOT-22 scores ($R = 0.6159$, $p = <0.01$).

No significant correlation was found between frontal pain scores and NOSE scores ($R = 0.01$, $p = 0.96$), frontal sinus opacification scores ($R = -0.2683$, $p = 0.05725$), or modified Lund-Kennedy scores ($R = -0.1685$, $p = 0.24$). A summary of each of the outcome measures is outlined in Table III.

DISCUSSION

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Surgical management of the frontal sinus is associated with increased morbidity, higher re-stenosis rates and more treatment failure compared to the other paranasal sinuses.[10] The decision to operate on the frontal sinus and the extent of surgery must therefore balance the expected symptomatic improvement against these risks. It is therefore crucial to understand the role of frontal pain in frontal sinus symptomatology.

Previous work into the extent of frontal sinus surgery have demonstrated improved outcomes following Draf II and Draf III procedures[4,11,12,] however very few high-quality comparative studies exist. In 2016, Abuzeid et al compared the outcomes of Draf I surgery with more extensive Draf II and Draf III surgery in a multi-centre prospective study. They showed that there was a comparable improvement in SNOT-22 scores between the groups and advocate that ethmoidectomy alone may be effective in the treatment of chronic frontal sinusitis in certain sub-groups.[10]

In 2020, Georgalas et al conducted a 5-year retrospective review of 99 patients who had undergone either Draf II or Draf III procedures. They demonstrated that both groups achieved a similar end-point quality-of-life although the Draf III group started from a significantly lower base-line. As the aim of all surgery is to improve symptoms whilst minimising risk there will be much interest if less extensive procedures can be shown to deliver equivalent outcomes.

In the context of CRS involving multiple sinuses and not responding to medical treatment, sinus surgery is usually indicated. Few surgeons in such a scenario will

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argue against performing a maxillary antrostomy if the maxillary sinus is involved with disease in the pre-operative C.T scan, even if the patient does not suffer from symptoms considered to be specific to the maxillary sinus, like pain in the cheek. However, a significant proportion of surgeons will choose not to perform a frontal sinusotomy for the same patient even when the frontal sinus is involved with disease in the pre-operative scan, unless the patient complains of symptoms specific to the frontal sinus. This discrepancy in decision making is likely to be related to the fact that frontal sinus surgery is more challenging than any other sinus surgery, rather than an actual difference in the pathology between the maxillary and the frontal sinuses which can justify treating them in different ways. The big question here is "What are the specific symptoms for frontal sinus disease?"

The dilemma remains that, apart from cases of frontal sinusitis presenting by orbital or cranial complications, we have no clear understanding of the symptoms related in particular to this sinus. This makes the planning of the extent of the surgery required for the frontal sinus, if any, more challenging. More high-level evidence is required to guide surgical decision-making and better understand the specific symptoms of chronic frontal sinusitis.

It is often considered that frontal pain/ headache is the most prevalent symptom of frontal sinus disease,[13] especially in cases when disease is limited to the frontal sinus alone.[14] However, frontal headache is not listed in the EPOS 2020 diagnostic criteria for CRS[15] and the International Headache Society believe that true frontal headache in the context of chronic pansinusitis is relatively rare[16.] Furthermore, the SNOT-22 questionnaire - the most commonly used quality-of-life questionnaire in CRS, does

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not specifically ask about frontal pain or headache.

This study aimed to explore the symptom of self-reported frontal pain in patients with proven chronic sinusitis and determine its utility as a specific marker for chronic frontal sinusitis. We demonstrated a moderate correlation with 'facial pain/pressure', a more commonly used diagnostic symptom for CRS and a weak correlation between frontal pain and QoL using the SNOT-22 questionnaire. We observed no correlation with nasal obstruction, endoscopic findings as measured by modified Lund-Kennedy scores or radiological frontal sinus opacification, indicating that frontal pain does not correlate with the objective evidence of frontal sinus disease. We therefore believe that the presence or absence of frontal pain should not be a factor when making a decision about operating on the frontal sinus.

Whilst there has been significant work understanding the relationship between endoscopic, radiological and clinical outcomes in CRS, to our knowledge there have been very few studies looking specifically at frontal pain in the context of frontal sinusitis.

In this study we demonstrated that in general, this patient group report low frontal pain scores and also low facial pain/pressure scores. Despite this, the majority of patients describe moderate to severe effects on QoL and both parameters were shown to correlate with SNOT-22 scores. The strength of this correlation, and other confounders however, must be considered, and it therefore remains uncertain whether or not frontal pain is a significant marker of QoL in CRS. Testing with both pre- and

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post-operative questionnaires, would improve validity and demonstrate the potential impact of surgical intervention on QoL.

Numerous previous studies have reported that there is no correlation between CT findings and the severity of patient-reported symptoms in CRS[17-19]. Whilst our own findings also demonstrate this, the only other study to examine the relationship between frontal pain and radiological assessment of the frontal sinus, does report an association. This study, by DelGuadio et al[20] observed a study population of 207 and found that in non-mucocoele CRS patients (n=170), those with mild to moderate mucosal thickening on CT exhibited a greater degree of frontal pain (64%) compared to those with complete opacification (37%) or minimal thickening (43%). They attribute this to an increased pressure differential across the sinus resulting from poor ventilation. In this study they also observed that patients with nasal polyps are significantly less likely to present with frontal pain than patients without polyps or patients with frontal mucocoeles. This is consistent with research in the wider context of CRS where it has been shown that facial pain is less common in patients with nasal polyposis than those without[21].

In our study, although a similar trend was demonstrated regarding the sP and wP groups this did not reach clinical significance ($p = 0.08$). Possible explanations for the variations between the studies are small patient numbers in the current study and different study design. DelGuardio et al documented the presence or absence of frontal pain retrospectively from patient records and classified the CT findings into three groups whereas in the current prospective study, patients were asked to rank their frontal pain on a numerical rating scale and CT scans were also scored on a

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point-system. This difference in numerical rather than categorical input data may have accounted for more nuances in the statistical calculation however further work is clearly required. To our knowledge this is the only study in which patients with frontal sinusitis have been asked to grade the extent of their frontal pain.

Numerical Rating Scales are a validated measure of pain in chronic disease with high test-re-test reliability[22]. An 11-point scale from 0-10 is most commonly used and is often categorised into: no pain = 0, mild pain = 1-3, moderate pain = 4-6, severe pain = 7-10, however this criteria has not been specifically validated for use in CRS and was not given to patients. Nonetheless, this study suggests that patients with chronic frontal sinusitis exhibit low frontal pain scores. This is in keeping with the consensus that the majority of patients with chronic frontal sinusitis will not complain of headache.[23] This is important in the wider context of frontal pain management as 88% of patients reporting sinus headache meet the International Headache Society diagnostic criteria for migraine [24] yet there is a high prevalence of missed diagnosis due to the overlapping symptoms of headache, nasal congestion, facial pressure or pain and rhinorrhoea.[25,26] To complicate things further, CRS and migraine commonly co-exist[27] and in a cohort study of 30,000 individuals Aaseth showed that patients with CRS had a 9-fold increased risk of having chronic headache.[28] Caution must therefore be taken when treating patients with frontal pain and sinusitis as a significant proportion of patients undergoing endoscopic sinus surgery describe persistent pain post-operatively.[27,29] To aid in this diagnostic challenge, Wu et al have proposed analysis of SNOT-22 score patterns and shown that patients with non-sinogenic headaches demonstrate higher scores in the ear/facial and psychological dysfunction questions than patients with CRS[30].

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Limitations

The limitations of the current study are due to its small sample size. It is possible that in a higher-powered study with a larger cohort an association between pain and disease type (sP, eP, wP) may have reached significance. It would also have been useful to have access to post-operative scores for each of the testing parameters to assess the impact of intervention although of course this was not in the study aims.

One patient did not complete a SNOT-22 questionnaire and was therefore excluded from analysis of facial pain/pressure and SNOT-22. It must also be noted that patients were asked to complete these questionnaires when assessed preoperatively either in the outpatient clinic or on the day of surgery, whereas CT scans were often performed several months prior to this. This however is common in this type of study and it is thought that radiological findings remain largely constant over time.

SUMMARY

- It is difficult to understand the specific symptomatology of frontal sinus involvement in chronic rhinosinusitis as it is rare to operate on the frontal sinus in isolation.

- This study explores the relationship between self-reported frontal pain, disease severity, and the extent of radiological and endoscopic frontal sinus disease.

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- Findings show that frontal pain is minimal in CRS patients and shows no correlation with the extent of frontal sinus disease radiologically or overall sinus disease endoscopically

- We are reminded to consider non-sinogenic headache in patients complaining of frontal pain.

- We conclude that frontal pain is not a sensitive nor specific marker of frontal sinus disease and do not recommend its use in the decision-making process for the extent of endoscopic frontal sinus surgery.

CONCLUSION

This study evaluated a sample of 51 patients undergoing endoscopic sinus surgery with objective evidence of chronic sinusitis. We found that in general, the frontal pain score amongst these patients is low and demonstrated no correlation between frontal pain and the extent of frontal sinus disease radiologically or frontal pain and the severity of overall sinus disease endoscopically.. Whilst a significant correlation was noted between higher frontal pain scores and worse QoL (as measured by the SNOT-22 questionnaire) this association requires further scrutiny and adjustment for confounding variables

This study therefore does not support the use of frontal pain as a sensitive or specific

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marker of frontal sinus disease and therefore cannot recommend its use in the decision-making process for the extent of endoscopic frontal sinus surgery. Patients presenting with this symptom should be properly counselled to exclude non-sinogenic headache and ensure they have realistic expectations regarding the improvement of their frontal pain post-operatively[21].

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COMPETING INTERESTS

The authors declare none

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Table I. Scoring systems used in patient assessment

Scoring system (maximum score)	**Aim of scoring system**
Fontal pain score (10)	Self-reported assessment of frontal pain
Facial pain/pressure score (5)	Self-reported assessment of facial pain/pressure (taken from SNOT-22 questionnaire)
SNOT-22 score (110)*	Validated self-assessment of health-related quality-of-life in chronic rhinosinusitis
NOSE score (100)	Validated self-assessment questionnaire of nasal obstruction
Frontal sinus opacification score (4) *from Lund-Mackay scoring system	Radiological assessment of sinus opacification
Modified Lund-Kennedy score (12)	Endoscopic assessment of polyps, oedema & discharge within the nose and paranasal sinus.

*SNOT-22 can be categorised into mild (8-20), moderate (21-50), severe > 50[9]

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Table II. Disease characteristics and frontal pain scores of study population by Chronic Rhinosinusitis (CRS) Type

	Male	**Female**	**Total**	**Mean frontal pain score**
CRS Type				
Sin Polyps (sP)	7	7	14	3.6
Ethmoid Polyps (eP)	8	4	12	3.0
With Polyps (wP)	19	6	25	1.9
Total	34	17	51	2.7

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Table III. Summary of outcome measures

	Range (maximum possible score)	**Mean**	**Inter-quartile range (IQR)**	**Significant correlation with frontal pain score (R-value, p-value)**
Frontal pain score	0-8 (10)	2.7	0-5	
Facial pain/pressure score	0-5 (5)	1.6	0-3	Yes (R = 0.64, p<0.01)
SNOT-22 score	8-107 (110)	50	37-61	Yes (R = 0.30, p = 0.04)
NOSE score	5-100 (100)	69	50-90	No (R = 0.01, p = 0.96)
Frontal sinus opacification score	0-4 (4)	3.4	2-4	No (R = -0.27, p = 0.06)
Modified Lund Kennedy Score	0-12 (12)	4.2	2-4	No (R = -0.17, p = 0.24)

AUTHORSHIP CONTRIBUTION

FJA: design, data analysis, drafting and revising manuscript

JT: design, revising manuscript

AE: conception, design, data acquisition, revising manuscript

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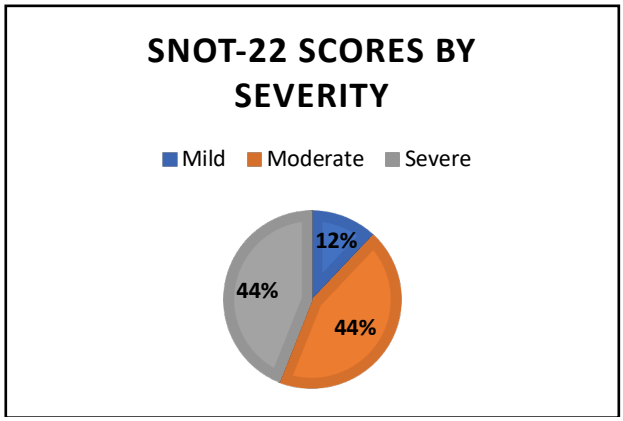
Figure 1. SNOT-22 scores by severity



Mild (8-20), Moderate (21-50), Severe >50

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