



# The Impact of Osteitis on Quality of Life in Patients with Chronic Rhinosinusitis

S Aparna<sup>1</sup> · Shibu George<sup>1</sup>

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## Abstract

**Introduction:** Chronic rhinosinusitis (CRS) is a significant health problem worldwide with an estimated prevalence of 5–12% in the general population. Osteitis refers to inflammation of bone characterized by bone remodeling, neo-osteogenesis and thickening of adjacent mucosa. These changes are evidenced by specific radiological appearance on Computerized Tomography (CT) which may be localized or diffuse dependent on extent of disease. Osteitis act as a marker of severity in chronic rhinosinusitis and can significantly affect the patient's Quality of Life (QOL) proportional to its severity. **Aim:** To analyze the impact of osteitis on quality of life in patients with chronic rhinosinusitis as evidenced by pre-operative Sinonasal Outcome Test-22(SNOT-22) scores. **Materials & Methods:** 31 patients diagnosed to have chronic rhinosinusitis with co-existing osteitis were enrolled in this study based on computerized tomography scan Paranasal Sinuses (PNS) findings and graded as per the calculated Global Osteitis Scoring Scale. Accordingly, patients were categorised into those without significant osteitis, with mild, moderate and severe osteitis. Baseline quality of life in these patients was assessed using the Sinonasal Outcome Test-22 (SNOT-22) and its association with the severity of osteitis analysed. **Results:** There is a very strong correlation between severity of osteitis and quality of life in the study population based on the Sinonasal Outcome Test-22 scores ( $p=0.000$ ). The mean Global Osteitis score was 21.65 with standard deviation 5.66. Maximum score obtained was 38 and minimum score 14. **Conclusion:** • Osteitis has a significant impact on quality of life in patients with chronic rhinosinusitis. • Severity of osteitis has a direct relation to quality of life in chronic rhinosinusitis.

**Keywords** Chronic rhinosinusitis · Osteitis · Global Osteitis Scoring Scale · Quality of life · Sinonasal Outcome Test-22(SNOT-22)

## Introduction

Chronic rhinosinusitis (CRS) is a significant health problem affecting about 5–12% of the general population[1], that results in the loss of productivity and has significant impact on the quality of life (QOL). The term “osteitis” is used to describe the sclerosis involving bony walls and septations of paranasal sinuses(PNS) in patients with CRS due to neo-osteogenesis[2]. Being a chronic low grade inflammation it need not be associated with direct bacterial invasion; rather,

it seems to be stimulated by and act as a ‘depot’ of inflammatory cytokines, which ensure the persistence of disease, even when the mucosa is either treated medically or removed[3]. On the contrary, some histopathological studies however describe osteitis as a process of neo-osteogenesis and bone remodelling rather than an inflammatory process. Though the prevalence of osteitis in CRS is estimated in literature to be around 40–50%[3–5], some studies have found it to be as high as 76%[6].

Osteitis can be graded radiologically using the Global Osteitis Scoring Scale (GOSS) which is a validated composite grading system that analyses its extent and severity in CRS based on Computerized Tomography (CT) scan analysis[7, 8]. It is the most validated radiological grading system for osteitis now.

Patient Reported Outcome Measures (PROMs) are subjective assessment of the QOL of patients with inflammatory sinus disease undergoing surgery, of which the most widely

✉ S Aparna  
aparnasnair.as@gmail.com  
Shibu George  
drshibugeorge@gmail.com

<sup>1</sup> Department of ENT & Head and Neck Surgery, Government Medical College, Kottayam, Kerala, India

accepted is the Sinonasal Outcome Test-22(SNOT-22). SNOT-22 is a 22-item disease-specific, health related questionnaire to assess the QOL in CRS patients, that has been validated in multiple languages. It can be further categorized into 5 subdomains; 3 sinus specific (Rhinologic, Extra-rhinologic and Ear/facial symptoms) and 2 general health-related QOL domains (Psychological and sleep dysfunction) which provides a fair assessment [9, 10]. In this study, we put into test the impact of PNS bony osteitis due to CRS on QOL of patients by comparing the disease related GOSS with SNOT-22 score.

## Methods

**Type of Study** Descriptive study.

**Study Duration** 18 months from February 2020 – August 2021.

**Study Setting** All patients with CRS with co-existing Osteitis (as measured by CT scan Nose & PNS undergoing Endoscopic Sinus Surgery (ESS) in a tertiary care hospital during the 18-month study period.

**Sample size** 31 patients were enrolled in this study.

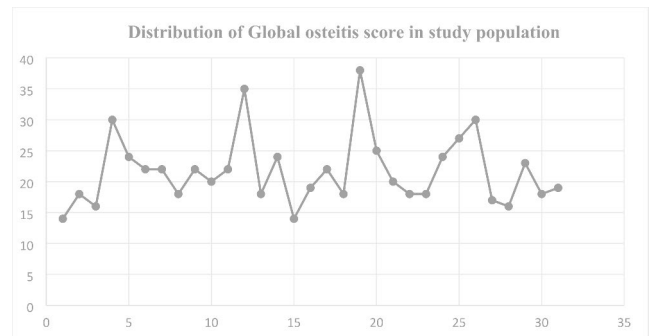
## Patient Selection

All patients with CRS, aged > 18 years, observed to have radiological evidence of osteitis, undergoing ESS were included in this study. Patients with no evidence of osteitis and those not willing to enroll in the study were excluded.

## Study Procedure

Patients with osteitis were identified based on GOSS after CT scan Nose & PNS. Assistance from the faculty members of Radiology department was sought as and when required for better interpretation of the tomography findings. Written informed consent was obtained from the patients included in this study. After clinical examination, a baseline SNOT-22 questionnaire was filled and the correlation between these scores and the severity of osteitis analyzed.

Data were coded and entered in Microsoft Excel and analyzed using IBM SPSS software. Quantitative variables were summarized using mean and standard deviation if they were normally distributed, while they were summarized as median and interquartile range if the distribution was skewed. Categorical variables were expressed as frequency and percentage. The association between 2 quantitative



**Fig. 1** Distribution of Global Osteitis Score in study population

variables with non-normal distribution was tested using Spearman's rho test. The level of statistical significance was fixed at  $p < 0.05$ .

## Results

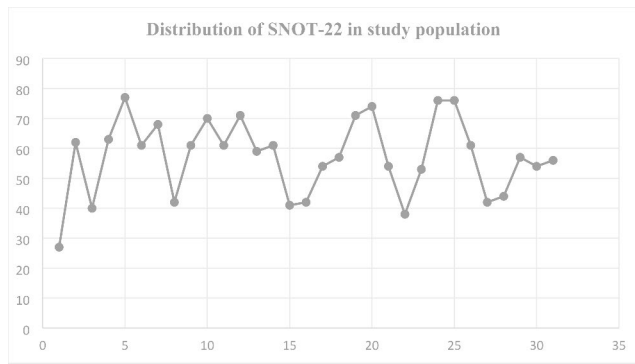
This study was conducted among 31 patients diagnosed to have CRS with co-existing osteitis on radiological evaluation. The mean age of the patients in this study was 48.32 years (Range 21 to 75 years). Among these, 48.4% were males and 51.6% were females. 38.7% among these patients were asthmatic. 90.3% among them had Chronic Rhinosinusitis with Nasal Polyposis (CRSwNP) and 9.7% had Chronic Rhinosinusitis without Nasal Polyposis (CRSsNP). 25.8% had history of previous sinus surgery with none undergoing more than one prior surgery.

Severity of osteitis was assessed radiologically using the GOSS. The grade of osteitis in each sinus on either side was calculated and added together to obtain the Global osteitis score. The mean observed score was 21.65 with a standard deviation 5.66; median was 20. The minimum score was 14 and maximum 38(Fig. 1).

Based on the Global Osteitis Score, patients were categorized into those without significant osteitis, those with mild, moderate, and severe osteitis. In this study, 51.6% (16) had mild osteitis (GOSS = 5–20), 45.2% (14) had moderate osteitis (GOSS = 21–35), 3.2% (1) had severe osteitis (GOSS > 35). Maxillary and frontal sinuses had radiological evidence of osteitis in all the study subjects; sphenoid sinus was involved in 96.8% and anterior and posterior ethmoid sinuses in 80.6% of the study subjects.

## Quality of Life Assessment Using SNOT-22

SNOT-22 was used to determine the baseline QOL of patients included in this study. The mean SNOT-22 score was 57.19 with a standard deviation 12.82. Maximum score recorded was 77 and minimum score 27(Fig. 2). Median score was 59.



**Fig. 2** Distribution of SNOT-22 in study population

**Table 1** Correlation between Global Osteitis Score and SNOT-22(N=31)

			Global Osteitis Score
Spearman's rho	Pre-op SNOT-22	Correlation coefficient	0.86
		P value(2-tailed)	0.000

Spearman's rho test, p value = 0.000

**Table 2** Global Osteitis Scoring Scale

GRADE	SINUS INVOLVEMENT
1	Less than 50% of the sinus wall is involved and osteitis < 3 mm wide
2	Less than 50% of the sinus wall is involved and osteitis 3–5 mm wide
3	Less than 50% of the sinus wall is involved and osteitis wider than 5 mm OR Greater than 50% of the sinus wall is involved and osteitis < 3 mm wide
4	Greater than 50% of the sinus wall is involved and osteitis 3–5 mm wide
5	Greater than 50% of the sinus wall is involved and osteitis wider than 5 mm
Total score < 5 - Not significant    21–35 – Moderate Osteitis	
5–20 – Mild Osteitis    > 35 – Severe Osteitis	

The distribution of Global osteitis score and SNOT-22 value showed a non-normal distribution. Hence, for analysing the correlation between the two, the non-parametric test, Spearman's rho was used (Table 1).

Here Spearman's correlation coefficient > 0.7(0.86) and p value < 0.05(0.000). Hence there is a very strong correlation between the severity of osteitis and SNOT-22 score.

SNOT-22 questionnaire was divided into subdomains (as proposed by de Conde et al.) and the predominant symptoms in these patients were analysed. Among the 31 patients with CRS with co-existing osteitis, 42% had predominant rhinological symptoms and 42% had predominant psychological symptoms; 16% had predominant sleep dysfunction and related symptoms. Among rhinological symptoms, the most common one was nasal obstruction, followed by runny nose and loss of smell/taste. Reduced concentration was the

most common symptom involving psychological domain while fatigue was the most prevalent sleep related symptom. Also, in patients with mild osteitis, rhinological symptoms predominated, whereas in those with moderate and severe osteitis, psychological symptoms predominated.

## Discussion

CRS is an inflammatory disorder of the nose and PNS with multifactorial, incompletely elucidated aetiology and has great impact on personal as well as social life. Osteitis in CRS causes inflammatory changes in the underlying bony walls and septations of PNS and may lead to recalcitrant CRS. There is ample evidence in literature on the association of osteitis with disease severity in CRS.

### Radiological Assessment of Osteitis in CRS – the Global Osteitis Scoring Scale

31 patients with CRS with co-existing osteitis as evidenced by CT PNS were enrolled in this study and disease severity in these patients were radiologically assessed using the Global Osteitis Score. GOSS is a validated composite grading system based on CT scan of PNS that analyses the extent and severity of osteitis[7].

The area of maximal thickness of osteitic focus of each of the sinuses is measured as the width of the osteitic bone[3]. Thus, each sinus is assigned a grading from 0 to 5(Table 2). The scores of all 10 sinuses (Right and left frontal, anterior ethmoid, posterior ethmoid, maxillary and sphenoid) are then added, which gives the global osteitis score (range: 0–50). GOSS thus incorporates both the severity of osteitis in each sinus as well as the number of sinuses involved[3].

### Distribution of Severity of Osteitis in the Study Population

The severity of osteitis was radiologically measured using the GOSS. The average grade of osteitis in CRS was found to be 9.2[3] by Georglas et al. (2008) in a prospective study of 102 patients undergoing CT PNS evaluation. However, we observed a higher severity of osteitis among study subjects in this study. The mean score obtained was as high as 21.65 with a standard deviation 5.654. Minimum score obtained was 14 and the maximum score 38. Based on the Global Osteitis Score, these 31 patients were grouped into 3 categories- those with mild osteitis, moderate osteitis and severe osteitis. In this study, 51.6% had mild osteitis (GOSS = 5–20), 45.2% had moderate osteitis (GOSS = 21–35), 3.2% had severe osteitis (GOSS > 35).

**Table 3** SNOT-22 questionnaire

SL.NO	Symptom	No problem	Very Mild	Mild/Slight	Moderate	Severe	Problem bad as it can be
1.	Need to blow nose	0	1	2	3	4	5
2.	Sneezing	0	1	2	3	4	5
3.	Runny nose	0	1	2	3	4	5
4.	Nasal Obstruction	0	1	2	3	4	5
5.	Loss of smell/taste	0	1	2	3	4	5
6.	Cough	0	1	2	3	4	5
7.	Post nasal discharge	0	1	2	3	4	5
8.	Thick nasal discharge	0	1	2	3	4	5
9.	Ear fullness	0	1	2	3	4	5
10.	Dizziness	0	1	2	3	4	5
11.	Ear pain	0	1	2	3	4	5
12.	Facial pain/pressure	0	1	2	3	4	5
13.	Difficulty in falling asleep	0	1	2	3	4	5
14.	Waking up at night	0	1	2	3	4	5
15.	Lack of good night sleep	0	1	2	3	4	5
16.	Waking up tired	0	1	2	3	4	5
17.	Fatigue	0	1	2	3	4	5
18.	Reduced productivity	0	1	2	3	4	5
19.	Reduced concentration	0	1	2	3	4	5
20.	Frustrated/restless/irritable	0	1	2	3	4	5
21.	Sad	0	1	2	3	4	5
22.	Embarrassed	0	1	2	3	4	5
	TOTAL						

Kong et al. (2020) found maxillary sinus to be the dominant sinus involved by osteitis in Non-eosinophilic-CRSwNP, and the ethmoids in Eosinophilic-CRSwNP, an observation reported by several other authors on the topic[11]. However, no predilection was noted for osteitis to any sinus in our study. Maxillary and frontal sinuses had radiological evidence of osteitis in all the study subjects; sphenoid sinus was involved in 96.8% and anterior & posterior ethmoids in 80.6% of the study subjects. In each patient, we also analysed the sinus maximum affected by osteitis. In 58.1%, it was the maxillary sinus, 35.5% frontal sinus and 3.2% each posterior ethmoid and sphenoid sinuses. Maximum involvement of the anterior ethmoids was not demonstrable in any patient.

### Quality of Life Assessment in CRS Using the SNOT-22 Questionnaire

SNOT-22(Sinonasal outcome test-22) is a 22-item disease-specific, health related questionnaire to assess the QOL in CRS patients. Each question carries a score ranging from 0 to 5 (a total score range of 0–110), with higher scores indicating poorer QOL(Table 3).

For better clarity of interpretation SNOT-22 questionnaire was categorized into 5 subdomains by de Conde et al. as follows : 3 sinus specific (Rhinologic, Extra-rhinologic & Ear/facial symptoms) and 2 general health-related QOL

domains (Psychological & sleep dysfunction)(Table 4)[9, 10].

The SNOT evaluation is not without pitfalls; the biggest disadvantage is that it fails to capture disease duration or usage of medications[1]. Moreover, despite its capacity to predict control status of CRS, some SNOT factors, such as ear complaints and emotional disorders, are not disease-specific.

### Correlation Between the Severity of Osteitis and Baseline Quality of Life Assessment Using The SNOT-22 Questionnaire

SNOT-22 questionnaire was used in our study to subjectively assess the QOL in the study population. This questionnaire has 5 subdomains with a total of 22 symptoms. Throughout the literature available so far, no substantial difference has been noted in the baseline QOL scores between patients with and without osteitis. Bhandarkar et al. (2011) found no difference in baseline QOL scores between patients with and without osteitis, though osteitis was found to be associated with worse baseline measures of severity and inflammation [12]. In a review on osteitis in CRS by Snidvongs et al. (2019), baseline quality of life PROMs were analysed. These include Visual Analogue Scale (VAS), Rhinosinusitis Disability Index (RSDI), Chronic Sinusitis Survey (CSS), the nasal component of Rhinosinusitis Outcome Measure (RSOM-31), and SNOT-22. These PROMs failed to report

**Table 4** SNOT-22 subdomains

SUBDOMAINS	SYMPTOMS	SCORE RANGE	
I - RHINOLOGICAL SYMPTOMS	<ul style="list-style-type: none"> <li>• Need to blow nose</li> <li>• Sneezing</li> <li>• Runny nose</li> </ul>	<ul style="list-style-type: none"> <li>• Thick nasal discharge</li> <li>• Loss of smell/taste</li> <li>• Nasal obstruction</li> </ul>	0–30
II – EXTRA-NASAL RHINOLOGICAL SYMPTOMS	<ul style="list-style-type: none"> <li>• Cough</li> <li>• Postnasal discharge</li> </ul>	<ul style="list-style-type: none"> <li>• Thick nasal discharge</li> </ul>	0–15
III – EAR/FACIAL SYMPTOMS	<ul style="list-style-type: none"> <li>• Sneezing</li> <li>• Ear fullness</li> <li>• Dizziness</li> </ul>	<ul style="list-style-type: none"> <li>• Ear pain</li> <li>• Facial pain/pressure</li> </ul>	0–25
IV – PSYCHOLOGICAL DYSFUNCTION	<ul style="list-style-type: none"> <li>• Waking up tired</li> <li>• Fatigue</li> <li>• Reduced concentration</li> <li>• Reduced productivity</li> </ul>	<ul style="list-style-type: none"> <li>• Frustrated/restless/irritable</li> <li>• Sad</li> <li>• Embarrassed</li> </ul>	0–35
V – SLEEP DYSFUNCTION	<ul style="list-style-type: none"> <li>• Difficulty in falling asleep</li> <li>• Waking up at night</li> <li>• Lack of good night sleep</li> </ul>	<ul style="list-style-type: none"> <li>• Waking up tired</li> <li>• Fatigue</li> </ul>	0–25

a worse baseline QOL score in patients with osteitis when compared to those without osteitis [6].

The mean SNOT-22 score was 57.19 in our study with a standard deviation 12.82; maximum score obtained was 77 and minimum score 27. A very strong statistical correlation could be inferred between the severity of osteitis and pre-operative SNOT-22 scores ( $p < 0.05$ ). This is in stark contrast to what is seen in the available literature on osteitis in CRS so far. The contradiction is possibly because all the patients included in this study had osteitis and we correlated the baseline SNOT-22 with the severity of osteitis rather than presence or absence of osteitis as in other studies.

Although there is a considerable overlap in the symptomatology of the two subtypes of CRS, there are differences in predominant symptoms. In patients with CRSwNP, main symptoms were nasal blockage and loss of smell [13–15] whereas in CRSsNP, the predominant symptom was facial pain. Rhinological symptoms form an integral part of SNOT-22 questionnaire and hence the baseline SNOT-22 scores are expected to be high in CRSwNP. In this study, 90.3% of the patients had CRSwNP which also might have contributed to a relatively higher baseline SNOT-22 scores.

De Conde et al. studied the correlation between the treatment modality selected by patients (medical/surgical) and the predominant SNOT-22 subdomain. It was noted that the patients electing ESS reported higher sleep and psychological dysfunction [9]. The impact of osteitis on the symptom domain was however not studied. In our study, we included only those CRS patients with osteitis, opting for ESS. Among these, 42% had predominant rhinological symptoms and another 42% had predominant psychological symptoms, 16% had predominant sleep related symptoms. It was also noted that in patients with mild osteitis, rhinological symptoms predominated, followed by psychological dysfunction, whereas in those with moderate and severe osteitis, psychological symptoms predominated. The initial impact of osteitis in CRS is possibly on the rhinological domain due to inflammatory process in the nasal and PNS mucosa, which then progresses and affect the function and psychological domain. In our study, majority of the patients had only mild osteitis, which might be the reason for an equal predominance of rhinological and psychological symptoms.

The histological definition of osteitis in CRS includes the presence of varying degree of increased osteoblastic-osteoclastic activity as evident from disruption of organised lamellar bone and formation of immature woven bone, presence of fibrosis, inflammatory cells and periosteal thickening [3, 4, 16, 17]. Sims and Quinn (2014) suggested that bone formation in CRS is not the direct effect of RANKL overexpression, instead is due to the effect of osteoblastic inflammatory cytokines such as OSM (Oncostatin M) and IL-23. Pothoven et al. (2015) found that OSM mRNA and protein were highly increased in nasal polyps and the cellular source of OSM were neutrophils thus suggesting a potential role of neutrophils in osteitis. Thus, osteitis is associated with severe inflammatory process, which also involves the overlying mucosa, resulting in increased nasal symptoms and hence worsening the QOL in such patients.

In this study, we could find worsening of baseline QOL parameters based on SNOT-22 score with the increase in severity of osteitis in patients with CRS. The predominance of psychological and sleep dysfunction with increase in severity of osteitis was also noted. Proper assessment of QOL using validated PROMs in all patients with CRS attending ENT outpatient departments is hence recommended. CT evaluation to rule out osteitis is recommended in longstanding and recalcitrant cases. Timely medical/surgical interventions in those patients with osteitis is essential to eradicate the underlying bony inflammatory process and hence improve their QOL.

## Key Messages

- Osteitis in CRS refers to neo-osteogenesis coupled with remodelling of the bony walls of paranasal sinuses. Though the role of true bony inflammation as the underlying pathology of the condition is yet to be proven osteitis is known to play a critical role in the elaboration of CRS by inducing persistent inflammatory changes in the surrounding mucosa.
- Osteitis serves as a marker of severity and has been increasingly recognized in patients with recalcitrant CRS resistant to treatment.
- Though a clear association between severity of osteitis and extent of CRS has been established in multiple studies there is no conclusive evidence for a negative influence on patient reported QOL parameters. As opposed to literature this study observed a very strong correlation between the radiological severity of osteitis and the baseline symptomatology / QOL of patients with CRS.

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## Declarations

**Conflict of Interest:** The authors declared no potential conflicts of interests with respect to the research, authorship and/or publication of this article.

**Consent** Consent was obtained from the study subjects and permission was obtained from the Institutional Review Board of the institution.

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