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The Impact of Osteitis on Disease Severity Measures and Quality of Life Outcomes in Chronic Rhinosinusitis

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Abstract

BACKGROUND—The significance of osteitis in the management of recalcitrant chronic rhinosinusitis (CRS) has yet to be clearly understood and clinical outcomes data for these patients is lacking. Osteitis has been characterized by inflammatory infiltrate, osteoneogenesis, and bony sclerosis with remodeling. In this study we sought to determine if osteitis negatively impacts quality-of-life (QOL) or clinical outcomes following endoscopic sinus surgery (ESS).

METHODS—190 adult patients with CRS were prospectively enrolled. Osteitis was characterized by quantifiable bony thickening on sinus computed tomography (CT). Baseline measures and post-operative outcomes were evaluated using endoscopy exam, olfactory testing, and two validated disease-specific QOL surveys: the Chronic Sinusitis Survey and Rhinosinusitis Disability Index (RSDI). Bivariate and multivariate analyses were performed to evaluate differences between patients with and without osteitis.

RESULTS—Patients with osteitis (n=79) had higher prevalence of nasal polyposis and prior ESS (both $p<0.001$) and significantly worse baseline CT, endoscopy, and olfactory scores (all $p<0.001$) than patients without osteitis. There was no difference in baseline QOL scores between patients with and without osteitis. Following ESS, there were significant improvements in all QOL measures in both groups, however patients without osteitis were more likely to exhibit clinically meaningful improvement on physical RSDI subscale scores, independent of other clinical factors (79.0% vs 62.3%; OR: 3.85, $p=0.011$).

CONCLUSIONS—Osteitis is associated with worse baseline measures of disease severity and inflammation. Our data suggest that while patients with osteitis improve after ESS, the presence of osteitis is associated with a reduced chance of improvement in some outcome measures.

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Keywords

Osteitis; endoscopy; sinusitis; quality-of-life; computed tomography

BACKGROUND

The significance of osteitis in the management of recalcitrant chronic rhinosinusitis (CRS) has been debated for several years and has yet to be clearly understood. Historically, there have been varying definitions and terms that have been used to describe bony involvement in CRS. “Osteitis” is the generally accepted term for inflammation in bone that lacks marrow space. Kennedy et al.[1] were the first to identify osteitic changes, which include inflammatory infiltrate, osteoneogenesis, and bony remodeling and sclerosis, in the ethmoid bone of CRS patients. Since then, a number of studies have contributed further to our understanding of osteitis in CRS, but relatively speaking, bone involvement has received much less attention than its mucosal counterpart in pathophysiology of CRS.

Physiologically, osteitis is characterized by varying degrees of increased osteoblastic-osteoclastic activity, resulting in disruption of organized lamellar bone and formation of immature woven bone.[2] Expansion of the haversian canal system with entry of inflammatory infiltrate in an increased vascular network has been demonstrated, wherein osteitis may act as a potential pathway for spread of mucosal disease.[3,4] Direct bacterial invasion of bone has not yet been demonstrated in studies to date, and it is still unclear whether osteitis is initiated by this event or perhaps is a response to inflammatory mediators.

The importance of studying the clinical impact of osteitis is perhaps best supported by the relatively high estimated prevalence of 36-53% in CRS patients based on either radiographic criteria of bony thickening or pathologic findings.[5] Although the extent of osteitis has been correlated to objective measures of disease severity such as higher Lund-Mackay computed tomography (CT) scores,[2,5,6] whether the presence of osteitis has a negative impact on quality of life (QOL) outcomes compared with patients without osteitis has not been previously studied. Additionally, determining whether endoscopic sinus surgery (ESS) plays a critical role in improving treatment outcomes in patients with osteitis requires further study. Current evidence supporting surgical removal of osteitic bone is anecdotal, suggesting that active inflammation in the underlying bone leads to persistence in overlying mucosal disease which does not resolve until the inflamed bony partitions are removed.[1,3] The goals of this study were: 1) to determine association between osteitis and measures of disease severity and, 2) to assess whether osteitis impacts QOL and disease specific outcomes in a cohort of CRS patients undergoing ESS.

MATERIALS and METHODS

Patient enrollment and data collection

The Institutional Review Board at Oregon Health & Science University (OHSU) approved this observational, prospective cohort study. Comprehensive outcome results of this cohort have been previously reported.[7] Adult (≥18 years) study patients with a diagnosis of CRS were identified from the Oregon Sinus Center at OHSU. Patient diagnoses were determined using guidelines established using the Rhinosinusitis Task Force criteria.[8] Voluntary, informed consent was obtained from all eligible subjects at an initial study enrollment meeting. All subjects elected to undergo ESS for CRS after sinonasal symptoms failed to resolve with medical therapy, including at least three weeks of culture-directed or broad-spectrum antibiotics and a trial of systemic corticosteroids. Endoscopic sinus surgery was performed by one of three enrolling otolaryngologists/providers at OHSU and tailored to the

individual disease process based upon clinical judgment. Surgical inclusion criteria required, at a minimum, unilateral or bilateral ethmoidectomy.

A comprehensive history and medical record review was completed for each subject at the enrollment meeting. All study data was collected on standardized case report forms and included information such as age, sex and history of prior sinus surgery, as well as disease cofactors such as nasal polyposis, asthma, acetylsalicylic acid (ASA) intolerance, allergy, depression, and current tobacco use. Follow-up appointments (≥ 6 months) corresponded to the normal postoperative standard of care. Data was collected at each clinic visit, deidentified, and manually entered into a secure database (FoxPro for Windows; Microsoft Corp., Redmond, WA.) by a research assistant.

Clinical measures of disease severity

Each enrolling physician reviewed standard preoperative noncontrast multi-planar CT images. Scoring of CT images was accomplished using Lund-Mackay staging (score range, 0-24). This system quantifies the degree of opacification in the maxillary, sphenoid, ethmoid, osteomeatal complex, and frontal sinuses.[9] Manual sinonasal endoscopy examinations were also performed both preoperatively and at each postoperative clinic visit using 2.7 - 4.0 mm. rigid endoscopes as part of the standard of care. Scoring of endoscopy exams was performed using the Lund-Kennedy method to quantify the severity of pathologic states within paranasal sinuses including polyposis, discharge, mucosal edema, crusting, and tissue scarring (score range, 0-20).[10]

Study subjects were asked to complete a test of olfactory function using the Smell Identification Test (SIT; Sensonics, Inc., Haddon Heights, NJ) both before surgery and at each postoperative clinic visit. The SIT is a validated, forced choice “scratch and sniff” test utilizing microencapsulated odorant strips (score range, 0-40).[11] All subjects with an SIT score ≤ 5 were excluded due to possible malingering.

Diagnostic criteria for osteitis

Electronic CT images of the sinuses were reviewed in a blinded retrospective fashion from a data warehouse using virtual image management software (Impax 6.3.1, Agfa Healthcare, Mortsel, Belgium) for all study subjects. The determination of concurrent osteitis in patients with CRS was derived by measuring degree of bony thickening in the ethmoid partitions, with osteitis diagnosed when ethmoid partitions measured at least 3 mm in thickness as previously described.[5]

Quality of life measures

Study participants were required to complete two health-related QOL surveys preoperatively and at each postoperative visit: the Rhinosinusitis Disability Index (RSDI) and the Chronic Sinusitis Survey (CSS). The RSDI is a 30 question survey consisting of three subscales that evaluate the impact of CRS on a patient's physical, functional, and emotional domain (score range, 0-120).[12] Higher RSDI scores indicate a greater impact of disease. The CSS is a 6 question survey developed to assess sinusitis-specific symptoms and medication use during the previous 8 week period (score range, 0-100).[13] Lower CSS scores represent a greater impact of CRS on a respondent. The research assistant assisted all patients with the completion of QOL instruments and each enrolling physician was blinded to all QOL responses for the duration of the study.

Statistical analysis

All analyses were conducted using statistical database software (SPSS v.18.0; SPSS Inc., Chicago, IL). Means, standard deviations (SD), ranges, and frequencies were calculated for

all measures, and normality of distributions for all continuous variables was evaluated. Pearson's chi-square tests were used to assess the frequency distribution of comorbid characteristics for patients with and without osteitis. Paired t-tests and Wilcoxon signed-rank tests were used to test for significant improvement in endoscopy scores, SIT, and QOL between preoperative and last postoperative follow-up where appropriate. Two-tailed independent *t* tests and Mann-Whitney U tests were used to compare differences in all QOL subscale and total outcome scores between patients with and without osteitis, without adjusting for multiple comparisons.

Multivariate logistic regression modeling was used to examine and adjust for patient characteristics that significantly predict improvement in QOL. The main independent variable of interest was confirmed, concurrent ethmoid osteitis in patient with CRS. Dependent variables were described as a clinically significant improvement in aggregate and subscale QOL and endoscopy scores defined by a change of at least ½ SD of the baseline score.[7,14] Improvement in SIT score was defined as ≥ 4 points.[15] Preliminary regression models utilized variables prescreened with univariate significance ($p \leq 0.25$). Final models were selected using forward selection ($p \leq 0.05$) and backward elimination techniques ($p \leq 0.10$) and adjusted for age, provider, nasal polyps, history of prior sinus surgery, gender, CT score, and baseline QOL where statistically and clinically meaningful. Crude and adjusted odds ratios (OR) and 95% confidence intervals are reported for patients with and without osteitis.

RESULTS

Patient Characteristics at Baseline

A total of 232 patients were originally enrolled at OHSU between November 2005 and April 2009. Patients were excluded from further review due to unavailable radiographic imaging (n=27). Patients who did not undergo unilateral or bilateral ethmoidectomy (n=7) and patients who had maxillary and/or sphenoid osteitis in the absence of ethmoid osteitis (n=8) were excluded in order to capture a more homogeneous population, wherein removal of ethmoid partitions during surgery was the main intervention of interest. A total of 190 patients were thus included in this cohort, with 79 (42%) of patients diagnosed with osteitis. Table 1 reports baseline demographic and clinical characteristics. There was no statistically significant difference between patients with and without osteitis in terms of mean follow-up, gender, allergy, depression, and tobacco use. The group of patients with osteitis was significantly older and had a higher proportion of patients with prior sinus surgery, nasal polyps, asthma, and ASA intolerance. In terms of objective measures of disease severity, the osteitis group had significantly higher CT and endoscopy scores and worse olfactory scores (all $p < 0.001$). As reported in Table 2, mean baseline QOL scores were statistically comparable between patients with or without osteitis.

QOL and Objective Outcomes After ESS

Differences in QOL and objective scores following ESS are reported in Table 3 for patients with and without osteitis. Both cohorts exhibited statistically significant, clinically meaningful improvement in both the CSS and RSDI subset and total scores. Endoscopy and olfactory scores also improved, however, mean olfactory scores in patients without osteitis did not significantly change postoperatively ($p = 0.595$).

When comparing QOL improvements between groups (Table 4), patients without osteitis exhibited significantly better mean improvements in the RSDI functional subscale ($p=0.047$). Improvement in total RSDI was also greater in patients without osteitis ($p=0.066$). No other RSDI or CSS subscales exhibited significant mean differences between

patient groups. Average endoscopy and olfactory scores also improved to a significantly greater extent in patients with osteitis compared to those without (both $p \leq 0.001$).

Multivariate Analysis of QOL Improvement

The percentage of patients exhibiting clinically meaningful improvement in QOL and objective measures is reported in Table 5. Patients with osteitis exhibited improvement in most QOL measures less commonly than patients without osteitis, however the difference was only statistically significant in the RSDI physical subscale (62.3% vs. 79.0%). After adjustment for age, provider, nasal polyposis, history of prior surgery, and baseline QOL the odds of improvement in patients without osteitis were 3.85 times that of patients with osteitis (p=0.011). Endoscopy scores were more likely to improve in patients with osteitis independent of other clinical factors (71.4% vs. 55.8%, OR 1.94, p=0.052). Olfactory scores were also more likely to improve in patients with osteitis (46.0% vs. 25.7%, OR 2.47, p=0.019), but did not demonstrate significance after controlling for the presence of polyposis.

DISCUSSION

In this cohort of adult patients with CRS undergoing ESS, there were several important findings regarding osteitis. Baseline measures of disease severity (CT, endoscopy, and olfactory function) were expectedly worse in patients with osteitis, supporting the current understanding that osteitis is associated with increased severity of inflammation. Patients with osteitis had significant mean improvement in olfactory scores while those without osteitis had essentially no change. Although this difference was statistically significant, the likelihood of improvement in olfactory scores was confounded by the presence of nasal polyposis, present in 77.2% of all patients with osteitis. Endoscopy scores were more likely to improve in patients with osteitis following ESS, independent of other patient characteristics. This finding suggests that there may be an important role and benefit for ESS in CRS patients with osteitis, wherein removal of inflamed, thickened ethmoid partitions results in a subsequent significant improvement in measures of mucosal inflammation.

Patients with osteitis had significant QOL improvements after ESS, but we found no substantial difference in the baseline scores or magnitude of mean improvements following ESS compared to patients without osteitis for the majority of QOL outcome measures. Interestingly, the presence of osteitis was associated with a reduced chance of improvement on physical subscale scores of the RSDI. From review of the specific survey items of the physical RSDI subscale, it is not readily apparent why patients with osteitis would be significantly less likely to improve in this domain only. However, given the trend of universally lower rates of improvement in nearly all QOL measures in patient with osteitis, a larger study population may provide a higher level of discrimination and demonstrate statistically significant differences in other QOL subscales. It is possible that a reduced prevalence of QOL improvement in the physical domain could be due to a worse aggregate physical impact from other cofactors associated with osteitis. These results, however, were durable after controlling for other significant factors, and therefore may prove to be an important aspect of preoperative counseling when osteitis is suspected based on CT evidence.

The exact definition and classification of osteitis varies between studies. We utilized a prior definition for osteitis using radiographic diagnostic criteria in an attempt to categorize patients based on our current understanding of osteitis in a consistent fashion.[5] In that tertiary care center study, 36% of patients were found to have osteitis when using CT criteria alone. Applying this definition to our cohort, we found a similar rate of 42% with osteitis. Interestingly, that study also found a 53% prevalence of osteitis when using histological

criteria. Histological analysis of bone was not performed in our study, and whether classification of patients based on such criteria would impact the measured outcomes requires further investigation.

Other definitions of osteitis in the literature deserve mention. Cho et al.[16] evaluated Hounsfield units (HU) on CT scan to diagnose osteitis. In that study, HU greater than 500 was established as the threshold beyond which osteitis was diagnosed. In an earlier study by the same authors, elevated HU correlated with increased mucosal and bony grading.[17] This definition emphasized bony sclerosis as the basis of elevated HU, which does not necessarily involve the same degree of bony thickening necessary to meet the criteria used by Lee.[5] We did not utilize Cho's methods in order to maintain a strict, easily identifiable single definition of osteitis; however, we acknowledge it may be potentially useful. Further study directly comparing and correlating bony thickening with elevated HU may be useful to expand upon our current understanding of the osteitis disease process as it relates to radiographic appearance.

Similarly, Jang et al.[6] discussed 99Tc-MDP bone isotope single photon emission computed tomography (SPECT) in CRS patients to characterize severity of osteitis. Increased isotope uptake was found to correlate to both increased baseline Lund Mackay CT scores and worse outcomes following ESS, as assessed by postoperative endoscopy findings of purulence, persistent edema, and recurrence of polyps. Though patients with poor outcomes had increased preoperative SPECT, it is unclear whether patients did in fact exhibit any level of improvement following ESS due to absence of an endoscopy scoring system. Also, it is difficult to determine whether or not outcomes could be directly attributable to osteitis as other associated baseline conditions, such as polyposis, were not evaluated. In our cohort, we similarly found higher baseline CT scores and higher postoperative endoscopy scores in patients with osteitis. However, we additionally found these patients exhibited both greater magnitude and increased likelihood of improvement in endoscopy scores after ESS. Overall, it would appear that the severity of osteitis by SPECT might be useful in predicting at least short term outcomes following ESS. The practicality of routine SPECT in patients whose CT findings are consistent with osteitis has yet to be determined.

The existence of several methods to detect osteitis may not be surprising. Kennedy et al.[1] have previously commented that “soft” osteitic bone develops into thickened osteoneogenesis over time. This natural progression perhaps lends justification to the identification of osteitis via relatively distinct methods, wherein there exists varying degrees of inflammation or stages in the disease process that have different objective characteristics. This situation could potentially impact our study results which utilized a binary measure of osteitis, when in fact the severity of osteitis exists along a continuum with corresponding impact on symptoms. There is no study directly comparing these methods, reinforcing that osteitis is still relatively poorly understood with need for further study.

There are study limitations to be considered other than those already mentioned. We did not have a comparison group of patients with ethmoid osteitis that were purely managed medically. This may prove useful for future analysis to determine both the natural history of osteitis in CRS as well as to what extent QOL improvement is specifically attributable to the surgical removal of diseased bone. Long term analysis of whether bony changes eventually reverse with any treatment has not been studied and may also be of benefit. Optimally, given the high prevalence of nasal polyposis and history of prior surgery in patients with osteitis, we would have performed subgroup analysis to look more closely at these and other factors we would typically associate with severe inflammation. This could not be accurately performed in a multivariate fashion due to insufficient sample size, but would be a useful avenue for further study to provide insight into whether the inflammatory events leading to

osteitis and its related QOL impact may differ depending on the specific CRS phenotype. Studies evaluating surgical outcomes in patients who have had prior surgery are typically susceptible to variations in the exact technique of that prior surgery. In patients who had prior surgery, we could not control for extent of ethmoidectomy and therefore the degree of residual partitions. Whether these partitions were osteitic at the time of prior surgery or rather developed as a result of interval worsening of disease severity leading to revision surgery also could not be determined. Lastly, findings of outcomes after surgery may not be generalizable beyond the follow-up period given possible changes in the natural history of the CRS disease process. This study experienced a 24% loss of patient follow-up. Although this potentially introduces selection bias, we feel this rate is reflective of ambulatory patients in a tertiary setting where changes in insurance status and preferred providers may change over time. No significant differences in baseline characteristics or measures of disease severity were found between patients with and without follow-up.

CONCLUSION

Osteitis is associated with worse baseline measures of disease severity and inflammation but similar baseline QOL compared to patients without osteitis. Our data suggest that while patients with osteitis improve after ESS, the presence of osteitis is associated with a reduced chance of improvement in some QOL outcome measures. Further study will be beneficial to better defining the exact nature and role of osteitis in the surgical management of CRS.

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Table 1

Comparison of baseline demographic and clinical characteristics for CRS study subjects with and without concurrent osteitis (n=190).

	Osteitis (n=79)			Non-osteitis (n=111)			
Variables:	**Mean (SD)**	**Range [LL, UL]**	**n(%)**	**Mean (SD)**	**Range [LL, UL]**	**n(%)**	**p-value**
Age (years)	49.5 (14.0)	[20, 77]		44.8 (13.6)	[18, 75]		**0.021**
Follow-up (months)	16.7 (6.4)	[5, 37]		17.7 (6.2)	[5, 39]		0.333
Gender							
Male			46 (58.2)			61 (55.0)	
Female			33 (41.8)			50 (45.0)	0.654
History of sinus surgery			57 (72.2)			48 (43.2)	**<0.001**
Nasal polyposis			61 (77.2)			29 (26.1)	**<0.001**
Asthma			38 (48.1)			30 (27.0)	**0.003**
Acetylsalicylic acid (ASA) intolerance			15 (19.0)			6 (5.4)	**0.003**
Allergy			18 (22.8)			29 (26.1)	0.599
Depression			11 (13.9)			18 (16.2)	0.665
Current tobacco use			6 (7.6)			4 (3.6)	0.324
CT score	17.0 (4.3)	[4, 24]		10.4 (6.2)	[0, 24]		**<0.001**
Endoscopy score	10.2 (3.6)	[0, 20]		5.3 (3.9)	[0, 14]		**<0.001**
Olfactory (SIT) score	21.4 (11.2)	[4, 38]		30.2 (8.2)	[6, 39]		**<0.001**

CRS, chronic rhinosinusitis; SD, standard deviation; LL, lower limit; UL, upper limit; CT,computed tomography scan; SIT, Smell Identification Test

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Table 2

Comparison of baseline quality of life scores for CRS study subjects with and without concurrent osteitis (n=190)

	Osteitis (n=79)		Non-osteitis (n=111)		
Measures:	**Mean (SD)**	**Range [LL, UL]**	**Mean (SD)**	**Range [LL, UL]**	**p-value**
RSDI physical	20.2 (7.3)	[2 - 38]	19.6 (7.3)	[2 - 37]	0.596
RSDI functional	15.5 (6.8)	[1 -31]	16.0 (6.7)	[1 - 34]	0.578
RSDI emotional	13.4 (7.2)	[0 - 39]	14.1 (7.7)	[0 - 39]	0.517
RSDI total	49.1 (18.8)	[8 - 104]	49.8 (18.8)	[3 - 105]	0.802
CSS symptom	23.7 (22.8)	[0 - 83]	29.3 (28.1)	[0 - 100]	0.255
CSS medication	49.7 (25.7)	[0 - 100]	51.9 (27.9)	[0 - 100]	0.581
CSS total	36.4 (18.4)	[0 - 75]	40.6 (21.0)	[0 - 96]	0.307

CRS= chronic rhinosinusitis; SD = standard deviation; LL, lower limit; UL, upper limit; RSDI = Rhinosinusitis Disability Index; CSS = Chronic Sinusitis Survey

Table 3

Differences between preoperative and postoperative mean outcome measures between CRS study subjects with and without osteitis over time (n=142)

	Osteitis (n=61)			Non-osteitis (n=81)		
Measures:	**Preoperative Mean (SD)**	**Postoperative Mean (SD)**	**p-value**	**Preoperative Mean (SD)**	**Postoperative Mean (SD)**	**p-value**
RSDI physical	19.4 (7.0)	11.4 (7.8)	**<0.001**	19.0 (7.4)	9.5 (7.1)	**<0.001**
RSDI functional	14.5 (6.7)	8.2 (7.0)	**<0.001**	15.6 (6.4)	7.1 (6.8)	**<0.001**
RSDI emotional	12.4 (6.7)	7.8 (6.9)	**<0.001**	14.0 (7.8)	7.5 (7.8)	**<0.001**
RSDI total	46.3 (17.7)	27.4 (20.1)	**<0.001**	48.6 (18.4)	24.0 (19.6)	**<0.001**
CSS symptom	23.1 (21.7)	60.3 (31.0)	**<0.001**	29.4 (27.2)	63.2 (27.3)	**<0.001**
CSS medication	47.9 (23.5)	55.3 (22.7)	**0.018**	47.2 (27.1)	61.7 (26.0)	**<0.001**
CSS total	35.5 (17.1)	57.8 (20.8)	**<0.001**	38.3 (19.8)	62.4 (21.4)	**<0.001**
Endoscopy score	10.4 (3.9)	4.5 (4.0)	**<0.001**	5.9 (4.0)	2.7 (3.0)	**<0.001**
Olfactory (SIT) score	20.6 (11.6)	27.4 (9.3)	**<0.001**	30.5 (7.5)	31.0 (7.6)	0.595

CRS= chronic rhinosinusitis; SD = standard deviation; RSDI = Rhinosinusitis Disability Index; CSS = Chronic Sinusitis Survey; SIT = Smell Identification Test

Table 4

Comparison of mean improvement in outcome measures between CRS study subjects with and without concurrent osteitis.

	Osteitis (n=61) Improvement		Non-osteitis (n=81) Improvement		
Measures:	**Mean (SD)**	**Range [LL, UL]**	**Mean (SD)**	**Range [LL, UL]**	**p-value**
RSDI physical	−8.0 (8.4)	[−31, 10]	−9.5 (7.0)	[−25, 7]	0.257
RSDI functional	−6.3 (6.4)	[−24, 9]	−8.6 (6.8)	[−27, 3]	**0.047**
RSDI emotional	−4.6 (6.6)	[−20, 9]	−6.5 (7.0)	[−28, 14]	0.098
RSDI total	−18.9 (18.6)	[−60, 13]	−24.6 (17.6)	[−72, 5]	0.066
CSS symptom	37.2 (33.7)	[−66, 100]	33.7 (30.2)	[−58, 100]	0.527
CSS medication	7.4 (23.6)	[−50, 59]	14.5 (29.1)	[−58, 84]	0.120
CSS total	22.3 (22.0)	[−29, 75]	24.1 (23.1)	[−45, 75]	0.629
Endoscopy score	−5.7 (4.8)	[−16, 6]	−3.1 (4.1)	[−14, 5]	**0.001**
Olfactory (SIT) score	7.1 (10.4)	[−10, 28]	0.2 (7.5)	[−27, 23]	**<0.001**

CRS= chronic rhinosinusitis; SD = standard deviation; LL, lower limit; UL, upper limit; RSDI = Rhinosinusitis Disability Index; CSS = Chronic Sinusitis Survey; SIT = Smell Identification Test

Table 5

Crude and adjusted odds ratios for the proportion of patients with and without osteitis experiencing clinically meaningful improvement in QOL (> ½ SD)

Outcome measure:	Osteitis (n=61) n (%)	Non-osteitis (n=81) n (%)	Crude OR	95% CI	p-value	Adjusted OR*	95% CI	p-value
RSDI physical	38 (62.3)	64 (79.0)	0.44	[0.21, 0.92]	**0.028**	0.26	[0.09, 0.73]	**0.011**
RSDI functional	40 (65.6)	57 (70.4)	0.80	[0.39, 1.63]	0.543	0.74	[0.29, 1.87]	0.523
RSDI emotional	34 (55.7)	52 (64.2)	0.70	[0.36, 1.39]	0.307	0.83	[0.40, 1.73]	0.613
RSDI total	40 (65.6)	62 (76.5)	0.58	[0.28, 1.22]	0.150	0.43	[0.16, 1.19]	0.104
CSS symptom	47 (77.0)	62 (76.5)	1.03	[0.47, 2.26]	0.944	1.08	[0.41, 2.86]	0.878
CSS medication	25 (41.0)	41 (50.6)	0.68	[0.35, 1.33]	0.255	1.36	[0.54, 3.42]	0.519
CSS total	42 (68.9)	61 (75.3)	0.73	[0.35, 1.52]	0.394	1.17	[0.46, 2.97]	0.739
Endoscopy score	45 (71.4)	48 (55.8)	1.98	[0.99, 3.96]	**0.052**	1.94	[0.96, 3.88]	**0.063**
Olfactory (SIT) score	23 (46.0)	19 (25.7)	2.47	[1.15, 5.29]	**0.019**	1.41	[0.57, 3.52]	0.460

QOL = quality of life; SD = standard deviation; OR = odds ratio; CI = confidence interval; RSDI = Rhinosinusitis Disability Index; CSS = Chronic Sinusitis Survey; SIT = Smell Identification Test