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# Management of odontogenic sinusitis: multidisciplinary consensus statement

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# Management of odontogenic sinusitis: multidisciplinary consensus statement

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***Background:*** Odontogenic sinusitis (ODS) can present a therapeutic dilemma because multiple treatment strategies have been reported. ODS review articles have been published, but they have lacked multidisciplinary collaboration and an evidence-based methodology. The purpose of this article was to perform an evidence-based review of ODS management options, and develop a multidisciplinary consensus statement on ODS management options.

***Methods:*** An evidence-based review of dental and medical literature on ODS management was performed using PubMed, EMBASE, and Cochrane Review Databases up to December 2019. Exclusion criteria included non-English-language articles, case series with fewer than 10 patients, fungal sinusitis, and studies that did not report treatment success rates. Because aggregate levels of evidence for recommendations were no higher than level C, a clinical consensus statement was conducted using a modified Delphi method.

***Results:*** Sixteen articles met inclusion criteria for the evidence-based review on the following ODS management options: dental treatment alone or combined with ESS for various dental pathologies, and endoscopic sinus surgery (ESS) alone for dental implant-related ODS. Strong consensus was achieved for 9 of the 10 clinical statements, the strongest being the use of shared decision-making for selecting management strategies. No consensus was reached for determining the extent of ESS necessary for uncomplicated ODS.

***Conclusion:*** Strong consensus was reached that ODS management should involve shared decision-making between the otolaryngologist, dental provider, and patient, where the benefits and risks of dental treatment and ESS are discussed. Higher-quality studies are necessary to develop evidence-based treatment recommendations for ODS. 

*Key Words:*
chronic rhinosinusitis; endodontic therapy; endoscopic sinus surgery; maxillary sinusitis; odontogenic sinusitis; oroantral fistula

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Bacterial odontogenic sinusitis (ODS) refers to maxillary sinusitis, with or without extension to other paranasal sinuses, secondary to either adjacent infectious maxillary dental pathology or iatrogenic injury from dental or other oral procedures. A variety of dental pathologies can lead to ODS, including endodontic disease, periodontitis, oroantral fistula (OAF), or dental treatment-related foreign bodies in the sinus.[1-8] Endodontic causes include pulpal necrosis, root fracture, apical periodontitis, and periapical lesions (PAL). PALs include periapical cysts, granulomas, or abscesses. Some studies have suggested that ODS accounts for 25% to 40% of all chronic maxillary sinusitis cases.[9,10] Other studies have shown ODS accounting for 45% to 75% of unilateral maxillary sinus opacification on sinus computed tomography (CT).[11-14] When ODS is due to treatable

dental pathology, management options include medical, dental, or sinus surgical treatments, or a combination of these.

Despite its relatively high prevalence, ODS has received significantly less attention in the literature than other forms of sinusitis, and ODS management has not been discussed in sinusitis guidelines.[15-17] Although there are multiple reasons for this, one issue has been the lack of multidisciplinary collaboration between dental providers and otolaryngologists. This has likely contributed to discrepancies in the understanding, diagnosis, and management of ODS between fields.

### Management of odontogenic pathology

When considering ODS management options, it is important to appreciate that different dental pathologies causing ODS may require different dental treatments. With regard to ODS from endodontic infections, the goal of endodontic treatment is to remove the pulpal and periapical infection leading to sinusitis. Antibiotic therapy alone is inappropriate without definitive dental treatment.[7,18-20] Root canal therapy (RCTx) treats endodontic infections by removing pathogenic bacteria, their byproducts, and necrotic debris from the infected root canal systems, followed by appropriate occlusal restoration to prevent reinfection.[21,22] RCTx can also resolve apical periodontitis and PALs.[23,24] However, some PALs will not respond to RCTx alone, and could require subsequent dental treatments, such as apicoectomy, intentional replantation, or dental extraction.[7,21,25]

The maxillary molars are the most common endodontic sources of ODS due to their anatomic location, and endodontic management of these teeth can be more challenging due to their complex root canal anatomy.[26-28] Based on the complexity of molar anatomy, the American Association of Endodontists recommended that molar endodontic treatments be managed by endodontists rather than general dentists.[29]

ODS may also be caused by chronic or marginal periodontitis, due to inflammation and infection of the gingiva, periodontal ligament space, and alveolar bone.[4,6,30] Periodontitis management is tailored to the severity of periodontal disease, but may include oral hygiene, oral antibiotics, periodontal scaling, resection of diseased gingiva or alveolar bone, and possibly dental extraction.[31] These cases should be managed by a periodontist or oral maxillofacial surgeon comfortable with managing potential complications such as OAF. OAF is managed by surgical closure, most commonly by either buccal mucosal or fat advancement flaps. High success rates have been reported for both of these techniques,[32] though insufficient evidence exists to determine whether one technique is superior.

Many review articles have been published on ODS, but a systematic, multidisciplinary review of the literature has not been performed. The purpose of this study was to review the highest levels of evidence on ODS management, and to develop a multidisciplinary clinical consensus statement (CCS).

## Materials and methods

A panel of 7 authors was assembled to conduct this study. Authors were selected based on their expertise in ODS, based on each having published studies on ODS or topics pertinent to ODS. First, the methodology described by Rudmik and Smith[33] for developing an evidence-based review with recommendations was followed. A systematic review of the literature was performed by conducting keyword searches through PubMed, EMBASE, and Cochrane Review, using the following terms: odontogenic sinusitis or rhinosinusitis, maxillary sinusitis, endodontic disease, apical periodontitis, periodontitis, oroantral fistula, root canal, dental extraction, oroantral fistula repair or closure, sinus augmentation or lift, dental implant. All dental terms were searched for in association with sinus disease. Randomized controlled trials were sought, and then other highest levels of evidence. Literature searches were performed up to December 2019.

Studies were reviewed if ODS was diagnosed by a combination of at least sinus CT demonstrating maxillary sinus disease, and dental testing and imaging that confirmed dental pathologies. The following exclusion criteria were applied: non-English-language articles, case series with fewer than 10 patients, fungal sinusitis, and studies that did not report treatment success rates. Additionally, studies on treatment of ODS with no treatable dental pathology were excluded, such as treatments for ODS due to temporary OAF after dental extraction, surgically closed OAF, and maxillary sinus foreign bodies.[34-40]

A total of 16 studies were included for evaluation and evidence-level grading using a reported research methodology.[41] Aggregate levels of evidence were determined for the following ODS management options according the strategies outlined by the American Academy of Pediatrics[42]: oral antibiotics alone, dental treatment alone, and combined dental treatment and ESS for various dental pathologies, as well as ESS alone for dental implant-related ODS. Pertinent literature was reviewed by all the authors.

After critical review of the literature, no treatment recommendations higher than level C ("option") could be reached. Therefore, a CCS was developed using a modified Delphi method.[43] Statements were developed based upon the evidence-based literature review, as well as authors' opinions of important clinical management decisions lacking published evidence. Statements focused on how appropriate the authors felt the following treatment options were for ODS due to treatable dental pathology (endodontic disease, periodontitis, permanent OAF, and dental implant–related ODS): antibiotics alone, dental treatment alone, combined dental treatment and ESS, and ESS alone specifically for dental implant–related ODS. Statements on the timing of dental treatment and ESS were developed relative to patients' sinonasal symptomatic burden.

Other statements included the extent of ESS for complicated and uncomplicated ODS, use of balloon sinus dilation, and whether shared decision-making is of utility.

Anonymous surveys were sent to all authors using SurveyMonkey.[44] A 9-point Likert scale was used to measure agreement, with the following answers: strongly disagree (1), disagree (3), neutral (5), agree (7), and strongly agree (9). Results were deidentified and analyzed. The following criteria for consensus were established a priori[43]: *consensus*: statements achieving a mean score of ≥7.00 and having no more than 1 outlier (defined as any rating 2 or more Likert points from the mean in either direction); *near consensus*: statements achieving a mean score of ≥6.50 and having no more than 2 outliers; and *no consensus*: statements that did not meet criteria for consensus or near consensus. A strong consensus was defined as a mean Likert score of ≥8 with no outliers.[45]

Two rounds of the Delphi survey were performed. After the first Delphi survey, 8 statements reached consensus and were accepted. Two statements that reached near consensus were discussed to determine if wording or language was responsible for not reaching consensus. The second Delphi survey was used to reassess items for which there was near consensus, and the results were discussed thereafter. All items reaching consensus were accepted. There was a true lack of consensus for one of the statements, and this was not due to wording or other modifiable factors.

## Results

### Literature review

Table 1 shows pertinent study data from the systematic review. Important studies from the review are summarized below, according to treatment type or topics pertinent to CCS development.

### Consensus statements

All authors completed the consensus surveys, and the results are shown in Table 2. Three of the statements were specific to rhinologic surgery (statements 7 to 9), and dental providers could not assess. Therefore there were 5 respondents for statements 7 to 9, and 7 respondents for the other statements. Overall, 9 of 10 statements achieved consensus. No consensus was reached for determining the extent of ESS necessary for uncomplicated ODS (statement 8). The strongest consensus was reached on statement 1, that optimal ODS management should involve a shared decision-making process between the otolaryngologist, dental provider, and patient, where the benefits and risks of dental treatment and ESS are discussed.

### Oral antibiotics alone

No studies have directly assessed the efficacy of oral antibiotics alone for ODS. Numerous case series have reported patients failing multiple courses of oral antibiotics before undergoing definitive dental treatment or ESS,[34-36,40,46-49] suggesting oral antibiotics alone are frequently unsuccessful at resolving ODS. For endodontic disease, antibiotic therapy without definitive dental treatment has been considered inappropriate.[7,18-20] Similarly, the panel reached consensus that oral antibiotics alone are inappropriate in the management of ODS due to any dental pathology amenable to dental treatment. Further study is necessary to determine whether some types of ODS could be cured by oral antibiotics alone.

### Primary dental treatment alone

In the setting of ODS due to endodontic or periodontal disease, only 1 study has reported a high success rate with primary dental treatment alone. Longhini and Ferguson[15] reported a 90% success rate when 21 patients underwent extraction (15/21) or RCTx (6/21), for PALs or periodontitis. However, sinonasal clinical outcomes and follow-up durations were not reported, and they included 6 patients who had failed prior ESS. Subsequent studies have generally shown significantly lower rates of ODS resolution with primary dental treatment alone. Mattos et al.[50] and Tomomatsu et al.[51] showed 52% and 51% success rates, respectively, after different primary dental treatments for ODS. The Mattos et al.[50] study did not report follow-up duration, and the Tomomatsu et al.[51] study reported clinical outcomes only at the end of a 3-month course of oral antibiotics following dental treatments. Craig et al.[34] prospectively followed 11 patients with ODS due to PALs treated primarily with either extraction (7/11) or RCTx (4/11), and 36% of them resolved during a short mean follow-up of 2.5 months, based on symptoms, 22-item Sino-Nasal Outcome Test (SNOT-22), and nasal endoscopy.

One of the consensus statements addressed primary dental treatment alone for ODS, and the panel agreed that for ODS patients who have treatable dental pathology, and have minimal or tolerable sinonasal symptoms, primary dental treatment should be pursued. Well-designed prospective studies are critical to determine the success rate of dental treatment for ODS, and which dental treatments are most effective.

### Combined dental treatment and ESS

The majority of case series have reported high success rates of 90% to 100% when both dental treatments and ESS are performed for ODS due to endodontic disease, periodontitis, permanent OAF, and dental implants. Studies have reported either concurrent dental treatment and ESS,[36,37,39,40,52-54] or primary dental treatment followed by ESS.[34-37,50,51] Ungar et al.[52] conducted a prospective case series of 25 patients who underwent concurrent ESS and dental treatment for ODS due to a variety of etiologies, including OAF (52%), foreign bodies (28%), and PALs (16%). They reported significant improvements in all sinonasal symptoms, SNOT-22, and nasal endoscopy at 3 months posttreatment. Akiyama et al.[53] performed a retrospective cohort study of 21 patients who

**TABLE 1.** Evidence-based literature summary table of studies on ODS management*

| Study (year) | Study design, LOE | N | Prior abx use | Dental pathology | Primary dental, ESS, or concurrent | Dental treatment | Sinuses opened during ESS | Median/mean follow-up | Treatment outcomes | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| Dental treatment only | | | | | | | | | | |
| Longhini and Ferguson[15] (2011) | Retro CS, 4 | 19 | 12/19 failed prior abx | 1) PAL (95%); 2) Periodontitis (5%) | Dental | 1) Extraction (15); 2) RCTx (4) | NR | NR | 95% Initial resolution; 100% After subsequent ESS | 1) No sinonasal outcome measures or follow-up times reported |
| Mattos et al.[50] (2016) | Retro CS, 4 | 43 | NR | 1) PAL (84%); 2) OAF or retained maxillary hardware (16%) | Dental | RCTx, extraction, or OAF closure | NR | NR | 52% Initial resolution; 100% After subsequent ESS | 1) Dental pathology and treatment frequencies not reported; 2) No outcome measures or follow-up times |
| Tomomatsu et al.[51] (2014) | Prosp CS, 4 | 39 | None | PAL | Dental | RCTx or extraction | NR | 3 months | 51% Initial resolution; 100% After subsequent ESS | 1) Frequencies of specific dental treatments not reported; 2) No long-term follow-up after 3-month course of posttreatment abx |
| Craig et al.[34] (2019) | Prosp cohort study, 2b | 37 | Failed prior abx | 1) PAL (54%); 2) Temp OAF (46%) | 1) Dental (11); 2) ESS, with or without secondary dental treatment (26) | 1) Extraction (7); 2) RCTx (4) | All diseased sinuses | 1° Dental: 2.5 months; 1° ESS: 5 months | Based on symptoms, SNOT-22, and nasal endoscopy:1° dental: 36%; 1° ESS: 100% | 1) Significantly faster clinical resolution in 1° ESS group; 2) No long-term follow-up of either group |

(Continued)

**TABLE 1.** Continued

| Study (year) | Study design, LOE | N | Prior abx use | Dental pathology | Primary dental, ESS, or concurrent | Dental treatment | Sinuses opened during ESS | Median/mean follow-up | Treatment outcomes | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| Combined ESS and dental treatment | | | | | | | | | | |
| Crovetto-Martínez et al.[35] (2014) | Retro cohort study, 4 | 55 | Failed prior abx | 1) PALs (69%);<br>2) OAF (16%);<br>3) Iatrogenic foreign bodies or sinus lifts (13%);<br>4) Peri-implantitis (2%) | 1) ESS, after prior dental treatment (46);<br>2) Concurrent (9) | OAF closure (9) | All diseased sinuses | 3 months | 94.5% Resolution, if patients at 3 months:<br>1) Asymptomatic;<br>2) No inflammation on endoscopy;<br>3) CT showed sinus ventilation without thickening >1/4 of max sinus | 1) Heterogeneous dental pathologies;<br>2) Did not describe prior dental treatments in ESS-only group;<br>3) No description of sinonasal symptoms;<br>4) No long-term follow-up |
| Felisati et al.[36] (2013) | Prosp CS, 4 | 257 | Failed prior abx | 1) Group 1: OAF from sinus lift (25/257);<br>2) Group 2: Dental implant-related ODS (57/257);<br>3) Group 3: Complications from "standard" dental treatment (175/275) | 1) Concurrent (135);<br>2) ESS after prior dental treatment (111) | OAF closure +/− implant removal | All diseased sinuses | 25 months | 1) Group 1: 96% (24/25) successful on first ESS + OAF closure;<br>2) Group 2: 96.5% (55/57) on first ESS + OAF closure, +/− implant removal;<br>3) Group 3: 100% in ESS only or ESS + OAF closure groups | 1) Did not specify which treatments were specific to bacterial ODS (198/257 were bacterial ODS);<br>2) Did not specify the "standard" dental treatment complications in Group 3;<br>3) Did not report sinonasal outcomes other than "complete healing" at 30 days postop |

*(Continued)*

**TABLE 1.** Continued

| Study (year) | Study design, LOE | N | Prior abx use | Dental pathology | Primary dental, ESS, or concurrent | Dental treatment | Sinuses opened during ESS | Median/mean follow-up | Treatment outcomes | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| Lopatin et al.[37] (2002) | Retro CS, 4 | 70 | NR | 1) OAF (56%);<br>2) Foreign bodies (30%);<br>3) Odontogenic cysts (14%) | 1) ESS alone (31);<br>2) Concurrent (39) | OAF closure (39) | All diseased sinuses | 1–3 years | 94% Initial resolution of symptoms | 1) Heterogeneous pathologies, mainly OAF and foreign bodies;<br>2) Did not report sinonasal outcome measures;<br>3) Did not report if dental treatments were necessary in ESS only group |
| Akiyama et al.[53] (2019) | Retro cohort, 4 | 21 | Failed prior abx | PALs after prior RCTx | Concurrent | 1) Apicoectomy (11);<br>2) Extraction (10) | All diseased sinuses | ≥3 months | 91% Symptomatic and endoscopic resolution;<br>No differences between apicoectomy and extraction | 1) Mean time to sinus healing was 6 to 7 weeks in both treatment groups |
| Ungar et al.[52] (2018) | Prosp CS, 4 | 25 | Failed prior abx | 1) OAF (52%);<br>2) Foreign bodies (28%);<br>3) PALs (16%);<br>4) Dental trauma (4%) | Concurrent | 1) OAF closure;<br>2) RCTx or extraction | MMA only | 11 months | 100% Resolution at end of follow-up, based on:<br>1) Significant change in preop to postop SNOT-22;<br>2) Decreases in all symptoms;<br>3) No inflammation on endoscopy | 1) All patients had frontal sinus opacification;<br>2) Did not compare to anterior ethmoidectomy or frontal sinusotomy;<br>3) Heterogeneous population, with only 16% PALs;<br>4) Did not assess time to disease resolution |
| Andric et al.[54] (2010) | Retro CS, 4 | 14 | NR | Permanent OAF after extractions | Concurrent | OAF closure | MMA only | 1) 6–24 months (10);<br>2) <6 months (4) | 100% Symptomatic and clinical resolution<br>100% OAF closure success | 1) Did not report symptom and endoscopic outcome measures |

*(Continued)*

**TABLE 1.** Continued

| Study (year) | Study design, LOE | N | Prior abx use | Dental pathology | Primary dental, ESS, or concurrent | Dental treatment | Sinuses opened during ESS | Median/mean follow-up | Treatment outcomes | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| Lee and Lee[38] (2010) | Retro CS, 4 | 27 | NR | 1) Dental implant-related ODS (37%);<br>2) Temp OAF after extraction (30%);<br>3) Odontogenic cysts (19%);<br>4) Caries (7%);<br>5) Supernumerary teeth (7%) | ESS, with or without 2° dental treatment | 2° Dental treatment, but types NR (19) | 1) ESS (25), but extent NR;<br>2) Caldwell-Luc (2) | 4.5 months | 100% Resolution | 1) Heterogeneous dental pathologies;<br>2) Did not report extents of ESS;<br>3) Did not report types of dental treatments after ESS;<br>4) No sinonasal outcome measures reported |
| Costa et al.[39] (2019) | Retro CS, 4 | 98 | NR | 1) PALs or periodontitis (39%);<br>2) OAF (26%);<br>3) Dental implant-related ODS (25%);<br>4) Temp OAF (7%);<br>5) Foreign body (3%) | 1)Concurrent (88)<br>2) ESS alone (10) | 1) Extraction (33);<br>2) OAF closure (22);<br>3) Dental implant removal (16);<br>4) Apicoectomy (7);<br>5) Bone graft removal (7) | 1) ESS + oral surgery (88);<br>2) ESS only, for temp OAF (10) | 6 months | 93% Resolution, based on:<br>1. Symptoms;<br>2. Endoscopy;<br>3. Sinus CT or CBCT | 1) Heterogeneous dental pathologies and treatments;<br>2) Did not report specific postop symptoms or endoscopic findings |
| Saibene et al.[40] (2019) | Prosp CS, 4 | 128 | Failed prior abx | 1) "Classic" dental treatments and disease (70%);<br>2) Dental implant-related (20%);<br>3) Sinus lift-related (11%) | Concurrent (70); ESS alone (58) | 1) ESS + OAF closure (31);<br>2) ESS + implant removal + OAF closure (13);<br>3) ESS + implant removal (9);<br>4) Foreign body removal (3);<br>5) ESS + bone graft removal + OAF closure (14) | Addressed diseased sinuses, except frontal | ≥6 months | 98% Symptomatic and endoscopic resolution | 1) Heterogeneous dental pathologies and treatments;<br>2) Did not specify frequency of ethmoid and frontal disease;<br>3) Did not specify time to resolution;<br>4) Included fungal sinusitis but did not report incidence |

*(Continued)*

**TABLE 1.** Continued

| Study (year) | Study design, LOE | N | Prior abx use | Dental pathology | Primary dental, ESS, or concurrent | Dental treatment | Sinuses opened during ESS | Median/mean follow-up | Treatment outcomes | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| ESS alone for dental implant-related ODS | | | | | | | | | | |
| Chen et al.[47] (2013) | Retro CS, 4 | 15 | Failed prior abx | Dental implant-related ODS | ESS (13) | 1° Implant removal (2) | All diseased sinuses | 20 months | 69% Resolution with dental implant preserva-tion; 31% Failed ESS, but resolved after implant removal + OAF closure | 1) Did not report postop sinonasal outcome measures |
| Kim et al.[48] (2016) | Prosp CS, 4 | 19 | Failed prior abx | Dental implant-related ODS | ESS (15) | 1° Implant removal (4) | All diseased sinuses | 2 years | 100% Endoscopic resolution, with dental implant preservation | 1) Did not report postop sinonasal symptom outcomes |
| Doud Galli et al.[49] (2001) | Retro CS, 4 | 14 | Failed prior abx | Dental implant-related ODS | ESS | None | MMA only | NR | 57% Resolution with dental implant preserva-tion; 43% Failed ESS but resolved after implant removal | 1) Did not report sinonasal outcome measures; 2) Did not report follow-up duration |

*Data are presented on dental pathologies, dental and sinus surgical treatment modalities, and treatment outcomes.
1° = primary; 2° = secondary; abx = antibiotics; CBCT = cone-based computed tomography; CS = case series; ESS = endoscopic sinus surgery; LOE = level of evidence; MMA = middle meatal antrostomy; NR = not reported; OAF = oroantral fistula; ODS = odontogenic sinusitis; PAL = periapical lesion; postop = postoperation; preop = preoperation; prosp = prospective; RCTx = root canal therapy; retro = retrospective; SNOT-22 = 22-item Sino-Nasal Outcome Test; Temp = temporary.

**TABLE 2.** Statements that did or did not reach consensus with regard to ODS management*

| Question number | Statement | Mean | Range | Outliers |
|---|---|---|---|---|
| ODS management statements that reached consensus | | | | |
| 1 | Optimal management of ODS involves a shared decision-making process between the otolaryngologist, dental provider, and patient, where the benefits and risks of dental treatment and ESS are discussed. | 8.86 | 8–9 | 0 |
| 7 | For complicated ODS (orbital or intracranial involvement), patients should undergo ESS, opening all diseased sinuses on CT scan. | 8.83 | 8–9 | 0 |
| 3 | For ODS patents who have treatable dental pathology, and have minimal or tolerable sinonasal symptoms, primary dental treatment should be pursued. | 8.57 | 8–9 | 0 |
| 2 | Oral antibiotics alone are not appropriate in the management of ODS due to dental pathology amenable to dental treatments. | 8.43 | 7–9 | 0 |
| 10 | Once the dental pathology causing ODS has been treated adequately, patients should be followed for at least 1 to 2 months posttreatment to monitor for sinusitis resolution. | 8.43 | 6–9 | 1 |
| 9 | Balloon sinus dilation may not be appropriate in patients undergoing sinus surgical intervention for ODS given the degree of inflammation and need for definitive sinus drainage | 8.40 | 5–9 | 1 |
| 4 | For ODS patients who have treatable dental pathology and have failed primary dental treatment, ESS should be pursued. | 8.29 | 7–9 | 0 |
| 5 | For ODS patients who have treatable dental pathology, but have significant sinonasal symptoms, primary ESS combined with subsequent dental treatment should be pursued. | 8.00 | 5–9 | 1 |
| 6 | For ODS due to maxillary dental implants, primary ESS should be pursued in efforts to preserve the dental implant. | 8.00 | 6–9 | 1 |
| ODS management statement that did not reach consensus | | | | |
| 8 | For uncomplicated ODS (no orbital or intracranial involvement), patients should undergo ESS, opening all diseased sinuses on CT scan (maxillary, ± ethmoid, ± frontal) | 5.40 | 3–9 | 2 |

*Statements are listed in order of mean score achieved, from highest to lowest, and from lowest to highest number of outliers.
CT = computed tomography; ESS = endoscopic sinus surgery; ODS = odontogenic sinusitis.

underwent concurrent ESS and either apicoectomy (11/21) or dental extraction (10/21) after previously failed RCTx. They showed 90.5% resolution of symptoms and endoscopic findings at 3-month follow-up, with no significant differences between apicoectomy and extraction. Crovetto-Martinez et al.[35] performed a retrospective review of 55 patients who underwent ESS after prior dental treatments, or concurrent ESS with OAF closure, and showed 94.5% success based on symptoms, nasal endoscopy, and sinus CT. Felisati et al.[36] published a large retrospective case series of 198 patients, showing 96% to 100% success in resolving ODS after concurrent dental treatment and ESS. They only included patients who had complications from prior dental treatments, but did not include patients with ODS due to primary endodontic or periodontal disease.

Two statements reached consensus with regard to combined dental treatment and ESS for ODS. First, the panel agreed that for ODS patients with treatable dental pathology, who fail primary dental treatment, ESS should be pursued. Second, the panel agreed that for ODS patients with treatable dental pathology, but who have significant sinonasal symptoms, primary ESS combined with subsequent dental treatment should be pursued.

## ESS alone for dental implant-related ODS

A controversial scenario arises when patients develop ODS after dental implant placement, perhaps in part because the precise cause of ODS in this setting is often not apparent. Dental implant removal may not always be indicated, as it may be associated with an increased risk of OAF development, more challenging reimplantation, and significant cost to the patient. Chen et al.[47] reviewed outcomes of 15 patients with dental implant-related ODS. Two patients required implant removal due to severe peri-implantitis. Of the 13 patients who underwent ESS alone, 9 resolved, and 4 had persistent ODS. Those 4 ESS failures resolved after implant removal and OAF closure. Doud Galli et al.[49] reviewed outcomes from 14 patients who underwent ESS for dental implant-related ODS, and 6 of those patients ultimately required both implant and bone graft removal due to ongoing bone graft infection. Kim et al.[48] prospectively followed 19 patients with dental implant-related ODS, 4 of whom required implant removal primarily. Of the 15 patients who underwent ESS alone, all patients resolved without implant removal, and all were followed for a minimum of 2 years postoperatively. The panel agreed that for ODS due to maxillary dental implants, primary

ESS should be pursued in efforts to preserve the dental implant.

### Timing of dental treatment and ESS

Regarding timing of dental treatment and ESS for ODS due to treatable dental pathology, very little evidence exists to support whether dental treatment or ESS should be performed primarily. Craig et al.[34] showed in a prospective cohort study that primary ESS resulted in significantly faster resolution of sinonasal symptoms, SNOT-22, and endoscopy findings, compared to primary dental treatment. More specifically, they showed that these variables resolved in 7 to 12 days after ESS, whereas patients successfully treated by dental treatment alone resolved in 35 to 56 days. These findings relate to statement 5 where panelists agreed that patients with significant sinonasal symptoms can benefit from primary ESS for faster symptomatic resolution, followed by dental treatment. Additionally, based on findings from Craig et al.[34] that successful dental treatments for ODS resolved symptoms in 35 to 56 days, ESS should be considered if patients have persistent sinusitis 1 to 2 months after primary dental treatment. Statement 10 reached consensus, stating that once the dental pathology causing ODS has been treated adequately, patients should be followed for at least 1 to 2 months posttreatment to monitor for sinusitis resolution.

### Extent of ESS

When ESS is performed for ODS with extramaxillary disease, one must consider which diseased sinuses to open. Multiple studies have demonstrated high success rates after opening all diseased sinuses.[34-37,40,47,48,53] However, no comparisons were made in those studies to more limited ESS for ODS with extramaxillary disease. One prospective series by Ungar et al.[52] reported outcomes after maxillary antrostomy alone for 25 ODS patients who had partial to complete ethmoid and frontal sinus opacification on sinus CT. They showed that all patients resolved by 3 months postoperatively. Craig et al.[34] reported opening all diseased sinuses in their 26 ESS patients, 17 whom had frontal sinusotomies for frontal disease, and all patients resolved by 7 to 12 days postoperatively. Two statements reached consensus regarding the extent of ESS for ODS, while a third statement failed to reach consensus. It was agreed that for complicated ODS (orbital or intracranial involvement), patients should undergo ESS, opening all diseased sinuses on CT scan. It was also agreed that balloon sinus dilation may not be appropriate in patients undergoing sinus surgical intervention for ODS given the degree of inflammation and need for definitive sinus drainage. No consensus was reached for statement 8 with regard to opening all diseased sinuses on CT during ESS for uncomplicated ODS (no orbital or intracranial involvement).

## Discussion

Despite low levels of published evidence on ODS management, studies have consistently demonstrated high success rates when both the dental and sinus pathologies are treated. However, the types of dental treatment, extent of ESS, and order in which patients undergo dental treatment and ESS may differ depending on type of dental pathology, extent of disease on CT, and sinonasal symptom burden.

Strong consensus was reached that ODS management should involve shared decision-making between the otolaryngologist, dental provider, and patient, where the benefits and risks of dental treatment and ESS are discussed. During the shared decision-making process, patients should be made aware that oral antibiotics alone are frequently ineffective at resolving ODS. If patients choose to undergo primary dental treatment for ODS due to endodontic or periodontal disease, it should be explained that sinusitis can persist and require subsequent ESS. Additionally, there is little evidence to suggest which dental treatment should be performed in these settings. Patients with dental implant–related ODS may resolve with ESS alone in patients with healthy, osseointegrated implants. However, patients may require implant removal if peri-implantitis is present. For ODS due to permanent OAF, combined ESS and OAF closure has been successful, but no studies have assessed whether the order in which they are performed affects outcomes.

Some of the consensus statements were created to help guide important clinical decisions that have not been reported in the literature. First, sinonasal symptom burden was considered in the decision to perform primary dental treatment vs ESS in statements 3 and 5. Although there is limited evidence to support these statements currently, the authors felt that symptom severity can be considered in the shared decision-making process when selecting a primary treatment modality. If patients have significant sinonasal symptoms and minimal dental complaints, primary ESS can be considered for faster symptom resolution, followed by dental treatment as needed. If patients have prominent dental complaints, and minimal or tolerable sinonasal symptoms, primary dental treatment should be pursued, followed by ESS if needed. ESS is often necessary after primary dental treatment either to treat sinonasal symptoms, or to prevent potential orbital or intracranial complications of ODS, as have been described in case reports.[55-59]

Extent of ESS for ODS was also felt to be very important for surgeons to consider. For statements 7 and 8, extent of ESS was considered in scenarios of uncomplicated and complicated ODS. In the setting of complicated ODS with orbital or intracranial complications, there was strong consensus that all diseased sinuses should be opened and drained. However, for uncomplicated ODS, no consensus was reached to open all diseased sinuses. This was due, in part, to mixed reports in the literature. Although most ODS series have reported opening all diseased sinuses, one case series showed success in managing ODS with

extramaxillary disease by maxillary antrostomy alone. However, no studies have directly compared maxillary antrostomy alone to other degrees of ESS. Based on this, authors felt the decision should be left to surgeon discretion. However, it is important for surgeons to be aware that limited ESS, even maxillary antrostomy alone, may be successful at resolving ODS, regardless of extramaxillary disease extent.

Appropriateness of balloon sinus dilation for ODS was also considered because no studies have assessed this. In a recent CCS on balloon sinus dilation,[45] balloon sinus dilation was not discussed with regard to ODS management. There was strong consensus that balloon sinus dilation may not be appropriate for ODS due to severe inflammation encountered in these cases, and the need for definitive sinus drainage. ODS patients often have severe middle meatal edema or polyps making identification and dilation of the maxillary sinus ostium difficult or impossible. Additionally, these patients often have severe intramaxillary edema, making definitive drainage challenging. However, ODS cases with minimal edema could potentially undergo successful balloon dilation and irrigation of the maxillary sinus, so it could be an option in a subset of these patients.

Last, little evidence exists in the literature with regard to appropriate follow-up of ODS patients after primary dental treatment. There was strong consensus that patients should be followed for at least 1 to 2 months after successful dental treatment to confirm sinusitis resolution. Authors agreed that if patients had persistent sinonasal symptoms for over 1 to 2 months after dental treatment, ESS should be offered.

One of the major benefits of this review and consensus article was to highlight gaps in the literature, to promote higher quality ODS studies in the future. Future studies ideally would include homogenous populations of dental pathologies and dental and sinus surgical treatments, so that overall treatment success can be stratified by specific dental pathologies. Appropriate outcome measures also need to be collected more consistently for both dental treatments and ESS. Last, multidisciplinary collaboration between otolaryngologists and dental specialists will be essential for making progress in the understanding and management of ODS.

## Conclusion

Strong consensus was reached that ODS management should involve shared decision-making between the otolaryngologist, dental provider, and patient, where the benefits and risks of dental treatment and ESS are discussed. High success rates can be expected if both dental and sinus pathologies are treated, but the types of dental treatment, extent of ESS, and order in which patients undergo dental treatment and ESS may differ depending on type of dental pathology, sinusitis extent on CT, and sinonasal symptom burden. More well-designed studies are needed to develop evidence-based ODS management recommendations, which will require collaboration between otolaryngologists and dental providers.

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