

# Augmentation of Therapeutic Efficacy of Extraction of Causative Teeth by Irrigation for Odontogenic Maxillary Sinusitis

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**Abstract.** *Background/Aim:* Odontogenic maxillary sinusitis is a clinically popular disease, but radical surgery and endoscopic surgery are often required. In the present study, we compared for the first time the therapeutic efficacy of the extraction of causative teeth with or without irrigation of the extraction fossa. *Patients and Methods:* A total of 60 patients underwent extraction of causative tooth. Among them, 34 patients underwent irrigation, while other 26 patients did not. Based on computed tomography (CT) images, treatment efficacy was quantified by the percentage of the remaining maxillary sinus mucosal lesions. The extent of therapeutic efficacy was evaluated following five grades, based on the percentage of remaining lesions: Grade 1 (0%) (disappearance of lesions), Grade 2 (roughly 10%), Grade 3 (roughly 30%), Grade 4 (approximately 50%) and Grade 5 (100%) (no improvement of the lesions). *Results:* Irrigation significantly augmented the therapeutic efficacy of tooth extraction for maxillary sinus mucosal lesions (mean grade: decreasing from 3.27 to 1.35). *Conclusion:* The combination of tooth extraction and irrigation may contribute to the reduction of the necessity of surgery for the maxillary sinuses.

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**Key Words:** Tooth extraction, irrigation, maxillary sinusitis, odontogenic maxillary sinusitis.

Odontogenic maxillary sinusitis (OMS) is a well-known disease in the field of otolaryngology and oral and maxillofacial surgery (1). When OMS is detected by oral inspection and X-ray examinations, computed tomography (CT) is essential to diagnose the extent of dental disease and sinusitis associated with OMS (2-4). Although this disease has both dental and otolaryngological characteristics, adequate criteria for prioritizing dental procedures at the initial stage of OMS treatment have not yet been established (1). Therefore, the treatment strategy of OMS considerably varies, depending on the medical institutions, and the attending physicians and dentists in charge. There are various choices for the extraction of causative tooth or root canal treatment; these include maxillary sinus irrigation during tooth extraction, and the use of antibiotics such as macrolide. It has been reported that 37.5% (1) and 22.9% (5) of the treatments of causative tooth were ineffective, and therefore surgery may be unavoidable. Most of maxillary sinus radical surgery and endoscopic surgery are performed in the hospitals, but quite a few patients do not want to undergo surgery. However, there is no scientific evidence that the extraction of the causative tooth and subsequent irrigation of the maxillary sinus are useful. Therefore, in the present study, we evaluated their therapeutic efficacy, based on the CT images of a total of 60 patients who underwent the extraction of causative tooth [with (34 patients) and without following irrigation (26 patients)].

## Patients and Methods

**Subjects.** Among the outpatients in the Department of Oral and Maxillofacial Surgery, Kanazawa Medical University Hospital from April 2013 to December 2023 (10 years and 8 months), 34 patients (23 males, 11 females) (irrigation group) were diagnosed with OMS, underwent the extraction of causative tooth, treated maxillary sinus irrigation for 3 days, and subjected to CT scans before and after the treatment, after obtaining their consent (Table I). A control group of 26 patients (16 males and 10 females) who were diagnosed with OMS also underwent the extraction of the causative tooth without



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Table I. Treatment outcome of irrigation groups (34 patients).

Patient's ID	Age/Sex	Cause	Medicine	Treatment period	Treatment progress	Grade
1	49/F	26, 27 Per	CAM	3M	NP	1
2	56/F	17, 18 Per	CAM	3M	NP	1
3	53/M	26, 27 Per	CAM	3M	NP	1
4	64/M	15 Per	CAM	3M	NP	1
5	72/M	14, 16 Per	CAM	3M	NP	1
6	42/M	16, 17 Per	CAM	3M	NP	1
7	82/M	17, 18 Per	CAM	6M	Fistula formation and closure surgery	1
8	75/M	17 Per	CAM	4M	NP	1
9	72/M	17 Per	CAM	3M	NP	1
10	44/M	17 Per	CAM	10M	Fistula formation and closure surgery	1
11	66/F	26 Per	CAM	3M	NP	1
12	72/F	16,17, 18 Per	CAM	3M	NP	1
13	53/M	17 Per	CAM	3M	NP	1
14	22/F	15 Per	CAM	3M	NP	1
15	64/F	16 Per	CAM	3M	NP	1
16	69/M	17 Per	CAM, Carbo	4M	NP	1
17	48/M	17 Per	CAM, Carbo	3M	NP	1
18	46/M	15 Per	CAM, Carbo, Desl	5M	Fistula closure, maxillary sinus OPE	5
19	47/M	18 Perico	CAM, Carbo	3M	NP	1
20	62/M	26 Per	CAM, Carbo	3M	NP	1
21	32/F	16, 17 Per	CAM, Carbo	3M	NP	1
22	63/M	16 Per	CAM, Carbo	3M	NP	1
23	58/M	26 Per	CAM, Carbo	5M	NP	2
24	40/M	26 Per	CAM	3M	NP	2
25	55/M	26 Per	CAM	3M	NP	1
26	43/F	27 Per	CAM	5M	Fistula, spontaneous closure	1
27	69/M	16 Per	CAM	3M	NP	1
28	70/F	27 Per	CAM	5M	Fistula formation and closure surgery	1
29	48/M	26 Per	CAM	3M	NP	1
30	79/F	15 Per	CAM	3M	NP	1
31	72/M	15, 16 Per	KTSS	3M	NP	2
32	45/M	26, 27 Per	CAM, Carbo	4M	Runny nose, going to sinus OPE	5
33	38/M	27 Per	CAM, Carbo	3M	NP	2
34	36/F	18 Per	CAM, Carbo	3M	NP	1
Mean	56.1					1.35

Per: Periodontitis; Perico: pericoronitis; CAM; clarithromycin; Carbo; L-carbocysteine; Desl: desloratadine; KTSS: Kakkontokasenkyushin'i; NP: no problem. Therapeutic efficacy was determined using the following five grades: disappearance of maxillary sinus mucosal lesions (MSML) (grade 1), (ii) roughly 10% remaining of MSML (grade 2), (iii) roughly 30% remaining (grade 3), (iv) roughly 50% remaining (grade 4), and (v) 100% remaining (no improvement) (grade 5).

irrigation, and subjected to CT scans before and after the extraction, after obtaining their consent (Table II). This study was approved by the Kanazawa Medical University Clinical Research Ethics Review Committee (approval number: #I466).

*Study design and sample.* The diagnosis of OMS was performed, when the following three criteria were satisfied by CT prior to treatment: (i) it is an apical lesion of the maxillary teeth, (ii) it is a maxillary bone defect between the maxillary sinus floor and the apical tip, and (iii) it is a maxillary sinus opacity. Patients who underwent CT scans only before and after surgery, and patients who had tooth extraction for OMS treatment were included in the study. However, patients who received endoscopic sinus surgery (ESS) alone or ESS together with dental care as primary treatment for OMS were excluded.

Physiological saline solution was injected *via* the oral cavity of the subjects into the maxillary sinus for three consecutive days from the day of tooth extraction, and waste was suctioned out through the nostril on the affected side. After that, in principle, a small amount of macrolide was orally administered for 3-6 months. During the follow-up period, based on the CT images and patient's symptoms, whether surgery on the maxillary sinus is necessary or not was decided. The controls were subjected to the same conditions of treatment except that the maxillary sinuses were not washed.

*Image evaluation of OMS:* In order to evaluate the OMS images, CT images were taken using SOMATOM Definition Flash (Siemens Healthineers & Co., Freistaat Bayern, Germany) before and after teeth extraction. The extent of therapeutic efficacy was evaluated

Table II. Treatment outcome of control groups (without irrigation).

Patient's ID	Age/Sex	Cause	Medicine	Treatment period	Treatment progress	Grade
1	46/M	17 Per	CAM	5M	Going to sinus OPE	5
2	76/F	27 Per	CAM	3M	Post nasal drip	3
3	49/M	26 Per	CAM	4M	Going to sinus OPE	5
4	36/M	28 Perico	CAM	2M	No improvement in symptoms	4
5	66/M	16 Per	CAM	2M	Going to sinus OPE	5
6	47/M	26 Per, WZ	CAM	12M	NP	1
7	73/F	26 Per	CAM	5M	NP	1
8	47/M	17 Per	CAM	5M	No improvement in symptoms	5
9	33/M	17 Per	CAM, Carbo, Mont	6M	Going to sinus OPE	5
10	60/F	17 Per	CAM	12M	NP	1
11	54/M	26 Per	CAM, Carbo	5M	NP	1
12	61/F	25 Per	CAM	3M	NP	2
13	46/M	17 Per	CAM, Carbo	3M	NP	2
14	67/F	25, 26 Per	CAM, Carbo	3M	3M	5
15	77/F	27 Per	CAM, Carbo	3M	Post nasal drip, OPE recommended	4
16	64/F	14 Per	Carbo	3M	NP	3
17	45/M	18 Per	CAM, Carbo	3M	NP	2
18	56/F	27 Per	CAM, Carbo	3M	NP	1
19	76/F	26 Per	CAM, Carbo	3M	Going to sinus OPE	5
20	55/F	26 Per	CAM, Carbo	3M	NP	2
21	44/M	25, 26, 27, 28 Per	CAM, Carbo	4M	Going to sinus OPE	5
22	46/M	26 Per	CAM	4M	NP	1
23	69/M	24 Per	CAM, Carbo	3M	Going to sinus OPE	5
24	46/M	26, 27 Per	CAM, Carbo	3M	No improvement in symptoms	3
25	42/M	28 Per	CAM, Carbo	3M	Going to sinus OPE	5
26	47/M	25 Per	CAM, Carbo	12M	No improvement in symptoms	4
Mean	54.9					3.27

Per: Periodontitis; Perico: pericoronitis; WZ: radicular cyst; CAM; clarithromycin; Carbo; L-carbocysteine; Mont; Montelukast sodium; NP: no problem. Therapeutic efficacy was determined using the following five grades: disappearance of maxillary sinus mucosal lesions (MSML) (grade 1), (ii) roughly 10% remaining of MSML (grade 2), (iii) roughly 30% remaining (grade 3), (iv) roughly 50% remaining (grade 4), and (v) 100% remaining (no improvement) (grade 5).

by the following five grades, based on the percentage of remaining lesions: Grade 1 (0%) (no lesions), Grade 2 (roughly 10%), Grade 3 (roughly 30%), Grade 4 (approximately 50%) and Grade 5 (100%) (no improvement of the lesions) (Figure 1).

**Study endpoints.** The primary endpoint of the study was delineated from CT imaging. A CT scan was performed 3–4 months after the tooth extraction. The end-point was disappearance of the maxillary sinus lesions (grade 1) or the remaining of roughly 10% of the lesions (grade 2). Other groups of patients were given a small amount of macrolide for an additional 3 to 9 months. If more than 50% of the maxillary sinus lesions remained with apparent symptoms (grade 4) or if there was no improvement in the lesions (grade 5), surgery on the maxillary sinus was recommended to reach the end point.

**Statistical analysis.** Wilcoxon signed-rank test and Fisher's exact test were applied to evaluate significant differences between two groups regarding the extent of maxillary sinus involvement on CT images and the surgical avoidance rate of OMS using IBM SPSS 27.0 (IBM Corp., Armonk, NY, USA). The significance level was set at  $p < 0.01$ .

## Results

Thirty-four patients (23 males and 11 females) (irrigation group) were diagnosed with odontogenic maxillary sinusitis (OMS), underwent extraction of the causative tooth and treatment with maxillary sinus irrigation for 3 days, followed by CT scans before and after the treatment, after obtaining consent (Table I).

The control group included 26 subjects (16 males and 10 females) who were diagnosed with OMS, underwent the extraction of causative tooth without irrigation, and had CT scans before and after the extraction, after giving their consent (Table II).

There were no significant differences in mean age (56.1 vs. 54.9) or sex (male: 67.6 vs. 61.5%) between the patient group who underwent the tooth extraction and maxillary sinus irrigation and the control group who underwent only the extraction of the causative tooth without irrigation (Table III). In addition, the irrigation group showed higher

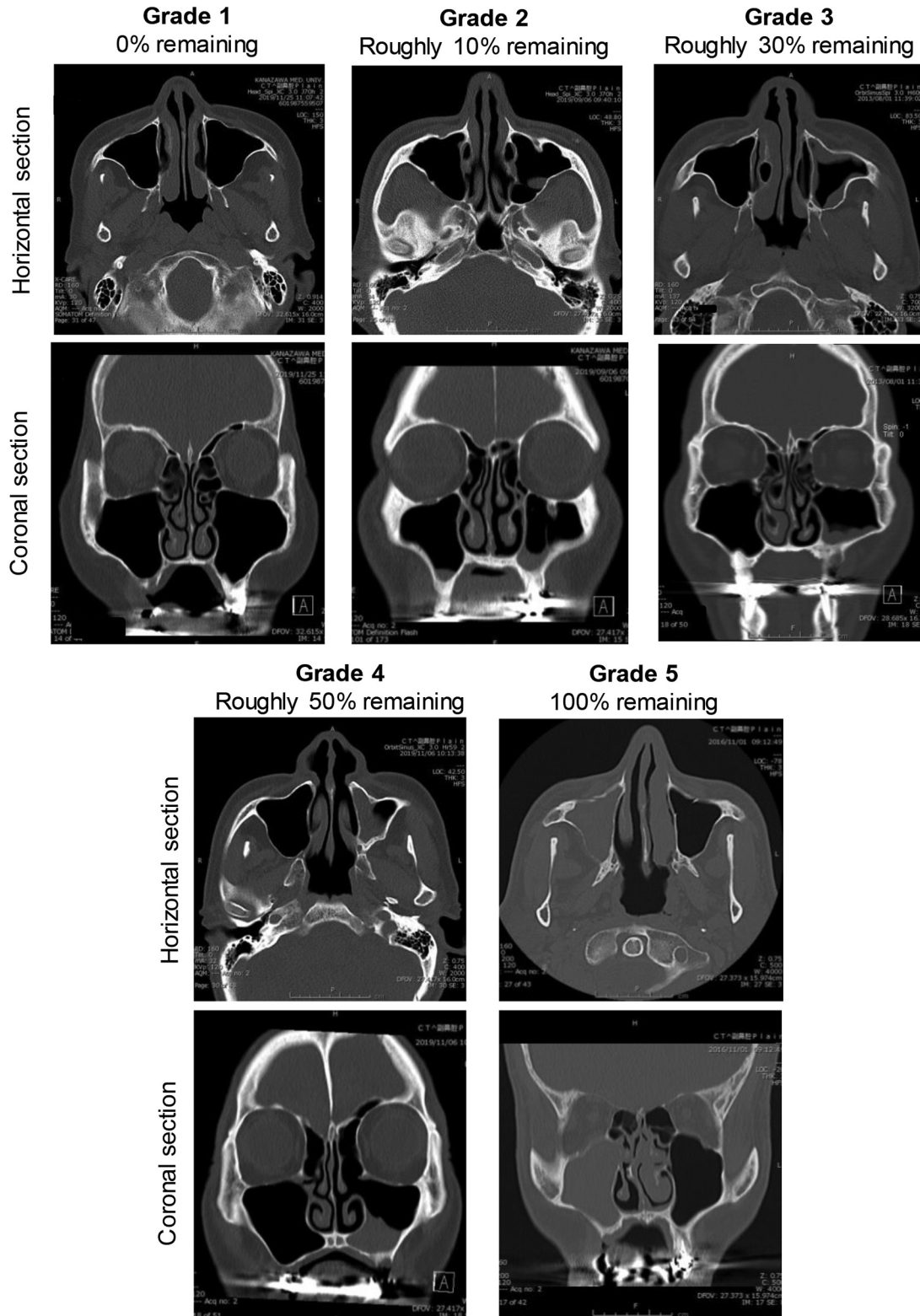


Figure 1. Computed tomography images of the therapeutic efficacy of tooth extraction and irrigation for odontogenic maxillary sinusitis (OMS). Depending upon the extent of remaining of maxillary sinus mucosal lesions, therapeutic effect was scored as Grade 1 (0% remaining mucosal thickening, disappearance of lesions), Grade 2 (roughly 10% remaining), Grade 3 (roughly 30% remaining), Grade 4 (roughly 50% remaining) and Grade 5 (100% remaining, no improvement), respectively. Upper panel: horizontal section; Lower panel: coronal section.

Table III. Characteristics of the patients with odontogenic maxillary sinusitis (OMS) included in the present study.

	Age (mean)	Sex, Male %	Site, n (%)	Grade of lesions	Non operation of OMS (%)	Fistula formation and closure surgery (%)
Irrigation (+)	56.1	67.6	Right sinus 74.8, Left sinus 25.2	1.35	94.1	11.8
Irrigation (-)	54.9	61.5	Right sinus 31, Left sinus 69	3.27	65.4	0

incidence of OMS on the right side (74.8 vs. 31.0%), whereas the control group showed higher incidence of OMS on the left side (25.2 vs. 69%). The irrigation group showed significantly ( $p<0.01$ ) higher rate of avoidance of surgery for maxillary sinusitis (94.1%) than the control group (65.4%). In addition, the proportion of maxillary sinus oral fistula requiring closure in the irrigation group (11.8%) was higher than that in the control group (0%) (Table III).

The therapeutic efficacy of irrigation was evaluated by the percentage of remaining lesions: Grade 1 (0%), Grade 2 (roughly 10%), Grade 3 (roughly 30%), Grade 4 (roughly 50%) and Grade 5 (100%) (Figure 2). We found that the irrigation group showed a significantly ( $p<0.01$ ) lower grade (mean value=1.35) compared to the control group (mean value=3.27).

**Discussion**

Odontogenic maxillary sinusitis (OMS) is a common disease in oral surgery and otolaryngology, and currently the most common evaluation method is the Lund-Mackay (L-M) score on sinuses CT (6). In this method, CT findings regarding maxillary sinuses, frontal sinuses, anterior ethmoid sinuses, posterior ethmoid sinuses, and sphenoid sinuses are classified into three categories: no opacity, partial opacity, and complete opacity. Therefore, it is difficult to make a detailed evaluation on CT images. To overcome this problem, we created a five-point scale to evaluate the extent of maxillary sinus mucosal lesions (MSML): (i) 0% remaining of MSML (disappearance of MSML) (grade 1), (ii) roughly 10% remaining (grade 2), (iii) roughly 30% remaining (grade 3), (iv) roughly 50% remaining (grade 4), and (v) 100% remaining (no improvement in MSML) (grade 5) (Figure 1). There is also a report that recommends tooth extraction for the treatment of the causative tooth of OMS (5).

In the present study, the tooth was extracted and then maxillary sinuses was irrigated with physiological saline for the following three days. Compared to the control group, significant improvement of the lesions was observed in the irrigation group (mean grade=1.35 vs. 3.27) (Table I, Table

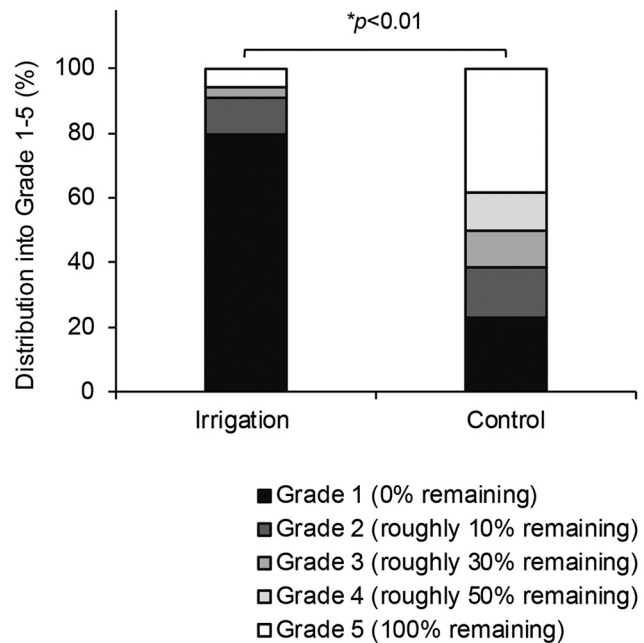


Figure 2. Diagram of therapeutic efficacy of irrigation. A significant difference was observed between the irrigation and control groups.  $*p<0.01$  by Wilcoxon signed-rank test.

II, and Table III). The rate of avoidance of surgery for OMS was very high (94.1%), indicating a significant difference from the control group (65.4%). In this case, injection of physiological saline into the maxillary sinus from the extraction fossa may stimulate the excreting of fluid from the nostril on the affected side. It is thus possible that this process may open up the closure of the foramen in the middle nasal passage between the maxillary sinus and the nasal cavity.

Even at the time of tooth extractions, as well as when liquid was not wasted from the nostrils at the time of tooth extraction, it was possible to cause a waste of liquid from the nostrils when irrigation was performed the next day. Patients said that they experienced the improvement of breathability by irrigation. This strengthens the possibility

that irrigation cures the OMS. Furthermore, the irrigation level of maxillary sinuses can be elevated by repeated trials. Even in actual clinical practice, the accumulation of waste was found to reduce day by day after irrigation. Even omission of irrigation yields some improvement (65.4%), consistent with previous report (1, 5). However, the present study demonstrated that approximately 6.7% of patients had maxillary sinus oral fistula, suggesting the necessity of sufficient follow-up. In fact, during the follow-up period, there were cases where maxillary sinus oral fistula closure was performed for outpatients.

In this study, small amounts of macrolides were used for most of the subjects, except one subject who was allergic to macrolides and used Kakkontokasenkyushin'i, a herbal medicine. Macrolides are effective for chronic sinusitis (CRS) accompanied by rhinorrhea and hypersecretion of nasal discharges, as well as for neutrophil-related inflammation accompanied by purulent or mucopurulent rhinorrhea. According to Japan's guidelines for macrolide therapy in the treatment of CRS, macrolides are usually given for 1~3 months (7). A 14-membered macrolide antibiotics such as clarithromycin is used in most of the cases as an anti-inflammatory agent, but not as an antimicrobial agent. Macrolide suppresses mucus secretion in the respiratory tract, improves the inflammation of the respiratory tract by suppressing the production of inflammatory cytokines, bacterial extracorporeal toxins and enzymes, and the formation of biofilm, and increasing the ciliary motility of the respiratory tract (8-10).

It has been reported that ESS should be performed first or at the same time with tooth extraction (5, 11-17). In the present study, tooth extraction was considered first. It is thought that there are few cases of ESS that are really needed. Therefore, two treatment methods of odontogenic maxillary sinusitis can be used, depending on the presence or absence of extraction of the causative tooth. The first method is to save the tooth by the root canal treatment of the tooth, without extraction. In the chronic phase, a small amount of macrolide is administered for three months and examined using CT. If it showed no favorable effect, ESS is performed. The second method is used, when the causative tooth was extracted. When it is possible to clean the maxillary sinus, it is washed with physiological saline from the extraction fossa into the maxillary sinus, and the waste fluid was suctioned out through the nostril on the affected side. This process was repeated for three days, and a small amount of macrolide is administered for 3-4 months. When this method has no effect, ESS is performed. The present study suggested that the treatment of odontogenic maxillary sinusitis should be selected using the above-mentioned methods.

In conclusion, irrigation significantly augmented the therapeutic efficacy of tooth extraction for maxillary sinus

mucosal lesions. The combination of tooth extraction and irrigation may contribute to avoid or reduce the frequency of the surgery for the maxillary sinuses.

### Conflicts of Interest

The Authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

### Authors' Contributions

TK performed the present study and wrote the manuscript. HS reviewed the manuscript and edited the manuscript. All Authors read and approved the final version of the manuscript.

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