Awareness Of Endodontists About The Association Of Maxillary Sinus And Root Canal Treatment - A Cross-Sectional Survey

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ABSTRACT: Odontogenic maxillary sinusitis (OMS) is a condition characterized by inflammation of the maxillary sinusitis due to dental infections or procedures, although a largely prevalent condition, it is often overlooked during initial assessments, leading to complications.

OBJECTIVE: The primary objective of this survey is to assess endodontists' knowledge, awareness, and practice regarding the association of the maxillary sinus and root canal treatment.

METHODOLOGY:

DATA COLLECTION: An online survey from April to July 2024 gathered data from 276 endodontists in India (200 females, 76 males) aged 23-60 years—the study comprised 23 questions in two parts. The first part gathered demographic data and the second part assessed participants' knowledge and awareness of the relationship of maxillary sinus.

DATA ANALYSIS: The survey was interpreted using descriptive and inferential statistical analyses. The responses of the participants based on years of experience were compared using the Chi-Square Test.

RESULTS This study evaluated the awareness of 270 endodontists, with 64.9% having less than five years of work experience and 35.2% having more than five years. Findings revealed that 51.4% of participants demonstrated adequate knowledge regarding the association of maxillary sinus and root canal. A majority (79%) believed gender influences sinus size, while 85.1% acknowledged a correlation between gender and the dimension of the sinus. 81.9% of the participants agreed that Cone-beam computed tomography (CBCT) as the preferred imaging modality, and considered periapical radiographs are insufficient for diagnosing odontogenic maxillary sinusitis (OMS).59.1% believed that teeth are always tender in OMS cases and limited awareness regarding the proximity of root apices to the sinus floor was seen among 70.4% of participants. Additionally, 62% acknowledged a link between periapical lesion size and OMS severity, but fewer than 30% were aware of the percentage of OMS cases attributed to dental infections.

CONCLUSION: This study identifies critical gaps in diagnosing and managing OMS. Despite some awareness, misconceptions and inadequate knowledge persist. The findings emphasize the need for enhanced training in recognizing OMS and integrating advanced diagnostic modalities like CBCT into endodontic practice.

INTRODUCTION

Odontogenic maxillary sinusitis (OMS) is a condition characterized by inflammation of the maxillary sinus due to dental infections or procedures. The close anatomical relationship between the maxillary posterior teeth and the floor of the maxillary sinus predisposes this region to such complications[1].

About 30-40% of tooth infections can cause odontogenic maxillary sinusitis[2]. In the case of unilateral maxillary sinusitis, the percentage rises to more than forty percentage[3]. Bomeli et al[4] found that the more severe the sinus disease, the more likely it was to be associated with dental pathology, with up to 86% of severely affected maxillary sinuses having a dental etiology for the infection.

The most common etiology of odontogenic maxillary sinusitis is a periapical or periodontal infection.

Other common etiological factors include failed endodontic treatment, tooth extraction, and dental implant complications. These odontogenic causes differ from non-odontogenic sinusitis, which typically stems from viral, bacterial, or allergic origins in the upper respiratory tract[5].

The most common teeth involved in odontogenic maxillary sinusitis (OMS) are the maxillary molars, particularly the first molar and second molar, followed by the maxillary premolars. This is due to the proximity of these teeth's roots to the floor of the maxillary sinus.[6] In many cases, the root tips of these teeth can extend into or lie near the sinus cavity, making them susceptible to spreading infections or inflammatory conditions into the sinus[7].

The microbiological profile of OMS differs from that of typical sinusitis. Studies indicate that anaerobic bacteria are more prevalent in odontogenic sinusitis cases compared to classic rhinosinusitis, which often involves aerobic bacteria.[8] This difference in microbial flora necessitates a tailored approach to the treatment of odontogenic maxillary sinusitis.

Recognizing OMS is important for proper diagnosis and treatment, as it requires both dental and sinus management are required to resolve the condition[9]. Misdiagnosis or delayed treatment may lead to chronic sinus problems and persistent dental issues[10].

This study highlights the critical importance of understanding the anatomy and relationship of the maxillary sinus with maxillary teeth for successful endodontic outcomes. The primary objective of this survey is to assess the knowledge, awareness, and practice of endodontists regarding the association of maxillary sinus and root canal treatment.

METHODOLOGY:

Study Setting & Participants: Participants in this cross-sectional survey were endodontists practicing in India. Ethical approval for the study was obtained from the Institutional Review Boards [KIMS /IEC /A216/D/2024].

Data Collection: An online questionnaire was conducted from April 2024- July 2024. The Rao soft web-based sample size calculation module (http://www.raosoft.com/samplesize.html) was employed to determine the requisite sample size. It was found that 276 participants would provide reliable results with a power of 80%, and a confidence level of 95%. A total of 200 females **and** 76 males from the age group of 23-60 years practicing in various private and academic institutions across India participated in this study.

This case report showed that the patient had an anterior open bite along with proclination in upper and lower front region of jaw. The proclination of both upper and lower teeth was reduced after treatment, along with ideal overbite. In order to prevent relapse following active therapy, it is crucial to instruct the patient to use the retainer on a regular basis. Relapse is possible, even if the patient use their retainers consistently. Therefore, to avoid relapse, routine follow-up to the orthodontic clinic is essential.

Age and Gender distribution among study participants			
Variable	Category	n	%
Age	20-29 years	174	63.0%
	30-39 years	46	16.7%
	40-49 years	41	14.9%
	50-59 years	14	5.1%
	> 60 years	1	0.4%
Gender	Males	76	27.5%
	Females	200	72.5%

Table 1: Age and Gender distribution among study Participants

Distribution of Professional Characteristics among study participants			
Variable	Category	n	%
Designation	PG Student	168	60.9%
	Faculty	67	24.3%
	Clinician	41	14.9%
Current Employment	Private Practice	52	18.8%
	General Practice	8	2.9%
	Academic Institution	184	66.7%
	Private & General Practice	5	1.8%
	Private Practice & Academic Institution	24	8.7%
	Private, General Practice & Academic Institution	3	1.1%
Work experience	< 5 years	179	64.9%
	5-10 years	33	12.0%
	> 10 years	64	23.2%

Table 2: Distribution of Professional Characteristics among study participants

The study comprised of 23 questions in two parts. The first part gathered demographic data including age, gender, designation, current employment, and work experience. The second part

assessed participants' knowledge and awareness of the relationship of the maxillary sinus and the maxillary teeth including its anatomy, etiology, clinical presentation, radiographic diagnosis, and the challenges in managing cases of maxillary sinusitis of odontogenic origin.

Questionnaire	
Variable	
1. Does gender affect the size of the maxillary sinus?	Yes
	No
2. Is there a correlation between the shape of the sinus and midface abnormalities?	Yes
	No
3. Do all cases of odontogenic MS have an overt periapical change in the radiograph?	Yes
	No
4. Are the teeth always tender to percussion in case of odontogenic MS?	Yes
	No
5. Do the teeth that are tender to percussion always show a negative response to pulp sensitivity tests in the case of odontogenic MS?	Yes
	No
6. Does the patient always present with dental symptoms in case of MS of endodontic origin?	Yes
	No
7. Does a periapical radiograph successfully detect odontogenic MS?	Yes
	No
8. Is there a positive correlation between the size of the periapical lesion and the severity of odontogenic MS?	Yes
	No
9. Which imaging modality is best for detecting odontogenic MS?	IOPA
	OPG
	CBCT
10. Which of the following maxillary molar root apex is closer to the sinus floor?	Mesiobuccal root apex of the maxillary 2nd molar
	Distobuccal root apex of the maxillary 1st molar
	Palatal root apex of the maxillary 2nd molar
	Palatal root apex of the maxillary 2nd molar
11. Pick out the true statements regarding change of sinus associated with age	At the age of 12 located at the level of the nasal floor.
	At the age of 20 reaches its largest size and descends to its lowest point
	In older individuals, the sinus floor extends further into the alveolar process & below the level of the nasal floor
	All of the above
12. What are the complications resulting from the extrusion of inflammation into the sinus?	Periapical Cellulitis
	Blindness
	Cavernous Venous Thrombosis
	All of the above
13. Characteristics of odontogenic MS.	Periapical radiolucency in the pulpally involved teeth close to the sinus floor
	Radiographic loss of lamina dura defining the lower border of the maxillary sinus over the pulpally involved teeth.
	Faint radio-opaque mass bulging into the sinus space involving the apex of the affected teeth
	Varying degree of radio-opacity surrounding the sinus space in comparison to the contralateral sinus.
14. Typical “fungal ball” aspergillosis of the maxillary sinus is seen due to	Over-extended root canal sealers
	Missed canals
	Perforation of maxillary sinus following apicectomy
	Inadvertent injection of irrigants.
15. Percentage of tooth infections that can cause MS?	10-12%
	30-40%
16. What percentage of dental pathology is seen in the case of unilateral MS?	< 40%
	> 40%
17. Most common endodontic cause of OMS	Extrusion of intracanal medicaments and obturating materials.
	Missed canals
	Apicectomies
	Cysts
18. What are the key challenges in managing cases of MS of endodontic origin?	Establishing correct diagnosis
	Working length determination
	Biomechanical preparation and obturation
	Postoperative healing

Table 3: Questionnaire

Data Analysis: The statistical methodology involves descriptive and inferential statistical analyses to interpret the survey data and assess relationships between variables.

Descriptive Statistics: Variables Analysed: Age, gender, professional characteristics

(e.g., designation, work experience), and responses to the questionnaire.

Inferential Statistics: Comparison Based on Experience: Responses to the study questionnaire were compared between participants with less than 5 years of experience and those with 5 or more years using the Chi-Square Test.

RESULTS:

Maxillary sinustitus						
Questions	Responses	< 5 years		≥ 5 years		P value
		n	%	n	%	
1. Does gender affect size of maxillary sinus?	Yes	144	80.4	74	76.3	0.42
	No	35	19.6 S	23	23.7	
2. Is there a correlation between the shape of the sinus and the midface?	Yes	149	83.2	86	88.7	0.23
	No	30	16.8	11	11.3	
3. Does all cases of odontogenic MS have an overt periapical change in the radiograph?	Yes	52	29.1	23	23.7	0.34
	No	127	70.9	74	76.3	
4.Are teeth always tender to percussion in OMS?	Yes	97	54.2	66	68.0	0.03 *
	No	82	45.8	31	32.0	
5. Do teeth that are tender to percussion always show negative response to pulp sensitivity tests in MS?	Yes	40	22.3	27	27.8	0.31
	No	139	77.7	70	72.2	
6.Does patient always present with dental symptoms in case of MS of endodontic origin?	Yes	87	48.6	51	52.6	0.53
	No	92	51.4	46	47.4	
7. Does periapical radiograph successfully detect OMS?	Yes	35	19.6	15	15.5	0.40
	No	144	80.4	82	84.5	
8. Is there a positive correlation between size of periapical lesion & severity of OMS ?	Yes	112	62.6	59	60.8	0.78
	No	67	37.4	38	39.2	
9. Which imaging modality is be for detecting OMS?	IOPA	12	6.7	4	4.1	0.48
	OPG	30	16.8	13	13.4	
	CBCT	137	76.5	80	82.5	
10. Which of following maxillary 1st molar root apex is closer to the sinus floor?	Mesiobuccal root apex of maxillary 2nd molar	35	19.6	20	20.6	0.77
	Distobuccal root apex of maxillary 1st molar	24	13.4	11	11.3	
11. Pick out true statements regarding change of sinus associated with age	At age 12 located at level of the nasal floor.	14	7.8	9	9.3	0.04 *
	At age 20 reaches its largest size & descends to its lowest point	21	11.7	7	7.2	
	In older individuals, sinus floor extends further into alveolar process & below level of nasal floor	4	2.2	9	9.3	
	All of above	140	78.2	72	74.2	
12. What are complications resulting from the extrusion of inflammation into sinus?	Periapical cellulitis	62	34.6	44	45.4	0.34
	Blindness	6	3.4	2	2.1	
	Cavernous venous thrombosis	23	12.8	9	9.3	
	All of above	88	49.2	42	43.3	
13. Characteristics of OMS.	Periapical radiolucency in pulpally involved teeth close to sinus floor	99	55.3	52	53.6	0.79

	Radiographic loss of lamina dura defining lower border of maxillary sinus over pulpally involved teeth.	109	60.9	64	66.0	0.40
	Faint radio-opaque mass bulging into sinus space involving the apex of affected teeth.	76	42.5	31	32.0	0.09
	Varying degree of radio-opacity surrounding sinus space in comparison to contralateral sinus.	91	50.8	42	43.3	0.23
14. Typical "fungal ball" aspergillosis of maxillary sinus is seen due to	Over-extended root canal sealers	85	47.5	42	43.3	0.80
	Missed canals	14	7.8	6	6.2	
	Perforation of maxillary sinus following apicectomy	57	31.8	36	37.1	
	Inadvertent injection of irrigants.	23	12.8	13	13.4	
15. Percent of tooth infections that can cause MS?	10-12%	129	72.1	71	73.2	0.84
	30-40%	50	27.9	26	26.8	
16. What percentage of dental pathology is seen in case of unilateral MS?	< 40%	135	75.4	75	77.3	0.72
	> 40%	44	24.6	22	22.7	
17. Most common endodontic cause of odontogenic MS	Extrusion of intracanal medicaments and obturating materials.	106	59.2	58	59.8	0.08
	Missed canals	20	11.2	17	17.5	
	Apicectomies	23	12.8	4	4.1	
	Cysts	30	16.8	18	18.6	
18. What are key challenges in managing cases of MS of endodontic origin?	Establishing a correct diagnosis	133	74.3	79	81.4	0.18
	Working length determination	99	55.3	47	48.5	0.28
	Biomechanical preparation obturation	97	54.2	50	51.5	0.67
	Postoperative healing	97	54.2	49	50.5	0.56

Significant responses of participants based on years of experience have been depicted in figure 1.

1. Tenderness to Percussion in Odontogenic Maxillary Sinusitis

Practitioners with ≥5 years of experience (68.0%) were significantly more likely to agree that teeth are always tender to percussion compared to those with <5 years of experience (54.2%).

2. Changes in the Maxillary Sinus with Age

While both groups largely agreed, practitioners with <5 years of experience (78.2%) were slightly more likely to choose this comprehensive understanding compared to those with ≥5 years of experience (74.2%).

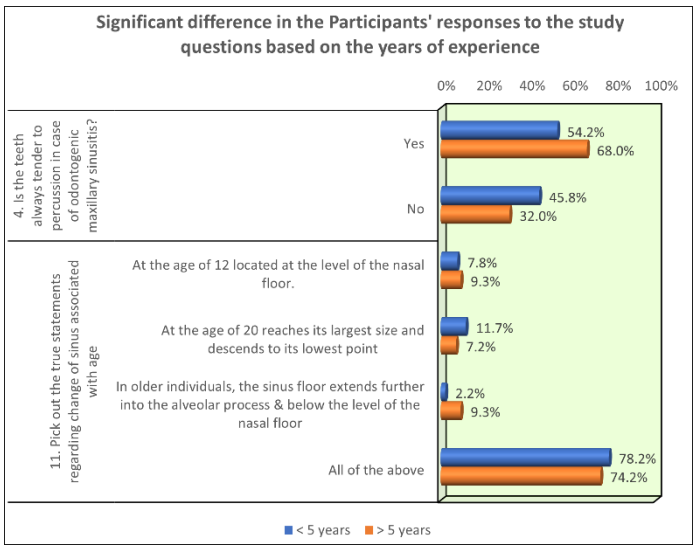

Figure 1: Significant responses of participants based on years of experience.

DISCUSSION:

The overall results indicated that the participants had adequate knowledge of the sinus-root canal association.

A significant majority of participants (79%) believed that gender affects the size of the maxillary sinus. This result reflects the awareness of anatomical variations between males and females. Males are more likely to have root protrusion into the sinus than females[11]. This highlights the need for practitioners to consider anatomical variations during diagnosis and treatment planning.

The finding that 85.1% of respondents agreed on a correlation between the shape of the sinus and midface structure emphasizes the recognition of the intimate relationship between craniofacial anatomy and sinus morphology. This is clinically relevant because any deviations in midface structure due to developmental anomalies, trauma, or surgery can affect sinus drainage and contribute to the development of sinusitis[12]. Understanding these relationships helps in anticipating complications and tailoring patient management.

Notably, 72.8% of participants indicated that not all cases of OMS exhibit overt periapical changes on radiographs. Although periapical radiolucencies are commonly associated with OMS, the absence of radiographic evidence does not rule out infection extending into the sinus. This supports the increasing reliance on more advanced imaging techniques, such as cone-beam computed tomography (CBCT), which can provide a more comprehensive evaluation of both dental and sinus structures[13]. The limitation of conventional radiographs may lead to misdiagnosis or delayed management. Also, 2/3rd of the identifiable dental pathology went unreported by radiologists on sinus CT scans[14.]

Majority of respondents consider a relatively lower percentage of tooth infections (10-12%) as being responsible for causing odontogenic maxillary sinusitis . According to literature, 30% - 40% of dental pathology is responsible for this condition and more than 40% of dental pathology is responsible for unilateral OMS[2,3], however only a minority of participants agreed to it reflecting a possible variation in clinical experiences or understanding of the condition's etiology.

The study revealed that 59.1% of participants reported that teeth are always tender to percussion in OMS, yet only 24.3% found these teeth to consistently show negative pulp sensitivity. This highlights a diagnostic dilemma—while percussion tenderness is a classic symptom of endodontic pathology, it is not always accompanied by pulp necrosis or loss of vitality.

Interestingly, the study found a split result, with 50% of participants agreeing that patients with maxillary sinusitis of endodontic origin (MSEO) do not always present with dental symptoms. This aligns with clinical observations where sinusitis may manifest with non-specific symptoms, such as facial pain, nasal congestion, or headache, rather than tooth pain[15]. This can make diagnosis challenging, particularly for general practitioners who may not immediately associate sinusitis with odontogenic causes. Also, it was found that the more severe the sinus disease, the more likely it was associated to be associated with dental pathology[16].Therefore, OMS requires careful consideration of sinus-related symptoms even when dental signs are absent.

The correlation between the size of periapical lesions and the severity of OMS was recognized by 62% of participants. This is consistent with the understanding that larger periapical lesions are more likely to breach the sinus floor and contribute to sinusitis[2]. However, it is crucial to acknowledge that lesion size alone is not always predictive of sinus involvement. Factors such as the proximity of the root apex to the sinus floor, the virulence of the bacteria etc also play a role in determining the severity of OMS.

Most of the participants agreed that the palatal root apex of maxillary first molar is closer to the sinus floor[17].Contrary to Georgescu et al[18] who reported that the mesiobuccal roots of 2nd molar were the closest to the sinus floor.

The most common endodontic cause of OMS identified by 59.4% of participants was the extrusion of intracanal medicaments and obturating materials[19]. This reflects a well-known risk during root canal therapy, particularly when treating teeth with roots that extend close to or into the sinus. The extrusion of materials can initiate an inflammatory response in the sinus, leading to sinusitis.

In terms of complications resulting from the extrusion of inflammation into the sinus, 47.1% of participants recognized periapical cellulitis, blindness, and cavernous venous thrombosis as possible outcomes[19]. This illustrates the serious potential risks associated with untreated or poorly managed OMS. Although rare, complications such as blindness or cavernous sinus thrombosis highlight the importance of early diagnosis and intervention to prevent the spread of infection to critical areas.

Finally, the study found that 76.8% of participants identified establishing a correct diagnosis as being the key challenge in managing OMS. However, in addition to establishing an accurate diagnosis, it is equally important to determine the correct working length, perform thorough biomechanical preparation, to ensure proper post-operative healing for optimal treatment outcomes.

Knowledge Gaps and Future Considerations:

While there was adequate awareness among participants regarding the relationship between the maxillary sinus and dental infections, the survey points out several areas for improvement:

- **Inaccurate Assumptions**: A high percentage of participants lacked knowledge about the *prevalence of dental infection***s** leading to OMS, with only *27.5%* being aware that 30-40% of tooth infections can result in sinusitis.
- **Treatment Risks**: The extrusion of *intracanal medicaments* and obturating materials was identified as a major cause of OMS, which further highlights the importance of *precise working length determination* and preventing material overextension during root canal therapy.
- Diagnostic difficulties may arise due to the overlapping symptoms of sinusitis and dental infections, particularly when radiographic evidence is inconclusive. This highlights the need for continued education and the integration of advanced diagnostic techniques, such as CBCT, in routine practice.

CONCLUSION:

The study emphasizes the need for improved diagnostic approaches and highlights significant gaps in the knowledge of endodontists proper diagnosis, a thorough understanding of the anatomical relationship between the maxillary teeth and the sinus, and precise treatment planning are essential to effectively manage OMS and prevent serious complications. This study serves as a tool to identify potential areas for improvement in endodontic practice, particularly in diagnosing and managing odontogenic maxillary-sinusitis.

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Conflict of Interest

None.

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