ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 12, Issue, 10, pp. 59833-59838, October, 2022
https://doi.org/10.37118/ijdr.25560.10.2022

REVIEW ARTICLE OPEN ACCESS

ASSOCIATION BETWEEN MAXILLARY SINUSITIS AND PERIAPICAL DISEASES: A SYSTEMATIC REVIEW

***Daniel Sousa Pardini, João Batista da Silveira Júnior, Lizandra Gonzaga Rodrigues, Gabriel Cavalcanti Nascimento, Lara Faria Pereira, Amaro Ilídio Vespasiano Silva, Vânia Eloísa de Araújo and Flávio Ricardo Manzi**

Department of Dentistry, Pontifical Catholic University of Minas Gerais, Dom José Gaspar Avenue, 500, Belo Horizonte, MG 30535-901, Brazil

ARTICLE INFO

Article History:
Received 08th September, 2022
Received in revised form
18th September, 2022
Accepted 20th October, 2022
Published online 30th October, 2022

Key Words:
Maxillary sinusitis; Endodontics; Odontogenic; Periapical diseases; Systematic review; Cone Beam Computed Tomography.

****Corresponding author:***
Daniel Sousa Pardini

ABSTRACT

Objectives: The purpose of this study was tosystematically evaluate the evidence on the association between maxillary sinusitis and periapicaldiseases. ***Methods:*** An electronic search were performed of the Cochrane Library, PubMed, Embase and LILACS databases up to September 2020. The gray literature was also searched. Additional studies sought through hand searching of endodontic journals. Observational studies associating maxillary sinusitis with periapical diseases, diagnosed by radiography and/or computed tomography/CBCT were included. Risks of bias assessment and data extraction were performed. ***Results:*** Fourteenstudies were selected and included in the qualitative analysis. Assessing methodological quality through the *Checklist* proposed by Downs and Black, most of the studies had scores below 0.50, not meeting most of the quality items. A meta-analysis cannot be performed due to the heterogeneity of the studies. According to the included studies, periapical diseases represented from 18% to 94.9% the etiology of odontogenic MS. ***Conclusions:*** Conflicting with other studies results, periapical diseases consisted the most frequent etiological factor associated with odontogenic MS.

Citation: ***Daniel Sousa Pardini, João Batista da Silveira Júnior et al.*** "Association between maxillary sinusitis and periapical diseases: A systematic review", *International Journal of Development Research*, 12, (10), 59833-59838.

INTRODUCTION

Maxillary sinusitis consists of an inflammation of the maxillary sinuses which can be classified according to its duration, severity and etiology and is one of the most diagnosed pathologies in the world. Representing the fifth, most common condition for prescribing antibiotics and is associated with a significant negative impact on the quality of life of those affected (Huntzinger, 2007). The intimate relationship between the maxillary sinuses and the root apice of the posterior upper teeth is well known, which explains that odontogenic infectionscan cause the rupture of the Schneiderian membraneand develop changes in the maxillary sinuses (Kretzschmar, Kretzschmar JL, 2003; Lu Y *et al.,* 1986; Melen I *et al.,* 1986; Shanbhag *et al.,* 2013). For this reason, it is particularly important to identify the etiology of MS to provide the appropriate treatment (Legert, Zimmerman, Stierna, 2003). Radiographs are important diagnostic tools for periapical changes and abnormalities of the maxillary sinuses. By contrast, they can cause overlapping of anatomical structures (Shanbhag *et al.,* 2013; Brook, 2006; Nurbakhsh *et al.,* 2003), as they are two-dimensional (2D) examinations of three-dimensional (3D) structures.

This does not occur in 3D examination modalities such as CT and cone beam CT, which can illustrate the degree of bone loss and the relationship between periapical lesions with MS (Hoskison *et al.,* 2003; Nurbakhsh *et al.,* 2003; Shanbhag *et al.,* 2013). The association between sinusitis and odontogenic causes is well defined in the literature. However, there is no clarity between the association and risk factors for periapical diseases and maxillary sinusitis. Although this association is clear, it is sometimes neglected in clinical practice. To establish these criteria, a systematic review was conducted.

MATERIALS AND METHODS

Study Design: This systematic review is reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (Moher *et al.,* 2009) (PRISMA) and registered on the PROSPERO database (CRD42020149674).

The research question was the following: What is the association between maxillary sinusitis and periapical diseases?

Search Strategy and Eligibility Criteria: Appropriate free-text key words and controlled vocabulary (MeSH terms) were used in the search strategies. The electronic search strategy was applied to the following databases up to September 2020: Cochrane Library, PubMed, EMBASE and Lilacs. Gray literature was searched through OpenGrey. ClinicaltTrials.gov was searched for ongoing or recently completed clinical trials. A manual search was also performed to avoid missing relevant studies.

No language or date restriction was applied to any of the searches. The search strategy was performed using the terms "maxillary sinusitis", "periapical diseases" and "odontogenic" combined by the Boolean operators AND/OR. The eligibility criteria were based on the Population, Exhibition, Comparison and Outcome criteria strategy, which included adults of 18 years or more with a diagnosis of MS (Population) comparing periapical disease as the cause of odontogenic MS (Exhibition) with other odontogenic factors (Comparison) to identify their association. Therefore, prospective, retrospective and cross-sectional studies that evaluated odontogenic factors as the cause of MS were included. Reviews, case reports, comment letters, letters to the editor, books, animal studies, studies including subjects younger than 18 years of age, studies using examination modalitiesother than radiography, CBCT or CT were excluded. The search strategy is shown in Supplemental file 1.

Study selection: Two reviewer authors (D.S.P. and J.B.S.J.) performed the study selection independently through the evaluation of the titles and abstracts of all studies identified in the electronic databases according to eligibility criteria. Full studies were retrieved and evaluated when their title and abstract did not provide enough information for a definite decision. Disagreements between the 2 reviewers at this stage were resolved by discussion with a third author (V.E.A.)

Quality Assessment: Selected studies were analyzed to verify their quality by two independent reviewers (D.S.P. and J.B.S.J.). If there was any disagreement at this stage, a third reviewer was requested (V.E.A.). The methodological quality of the included studies was evaluated by the Checklist proposed by Downs and Black (Downs, Black, 2009). This tool includes 27 items distributed into 5 subscales: 1) Reporting (09 items); 2) External validity (03 items); 3) Bias (07 items); 4) Confounding (06 items); 5) Power (01 item). Each of the 27 items were answered and scored 0 or 1, except for one item in the Reporting subscale, which scored 0 to 2, and the single item on power, which was scored 0 to 5. The total maximum score was 31. To assess answers to the 27 quality criteria, a score indicating the quality of the article was created, dividing the number of positive items by the total number of items evaluated.

Data Extraction and Synthesis of Evidence: The main characteristics of the included studies were extracted by two reviewers (D.S.P. and J.B.S.J.) and arranged into a data table. Even though most studies had thesame primary objective, their methodologies differed regarding the diagnosticexamination modality for diagnostic purpose and the subclassification of odontogenic etiologies of MS. The list of general characteristics of the selected studies is shown in table 1.

RESULTS

The search process screened 1169 references, published until September 2020. After the duplicates were removed, eligibility criteria were applied to 1149 articles. Forty studies were selected for full-text reading. After eligibility criteria application, 14 articles were selected for data extraction and qualitative analysis. The flowchart is present in Figure 1. The included studies were published between 1993 and 2019. These studies were carried out in Belgium (14), Brazil (15,16), Canada (17), Germany (18), India (19), Japan (20), Lithuania (21), Portugal (22), Sweden (23,24) and USA (25,26,27). Patient age ranged from 18 to 94 years (mean 49.31). Women represented 52.15% of the subjects, whilemen represented 47.85%. Evaluating the etiologies of odontogenic MS, most of the studies showed endodontic factors as the most common cause, showing a prevalence ranging from 18%to 94.9% (Bajoria AA, Sarkar S, Sinha P. 2015; de Lima CO *et al.,* 2017; Guerra-Pereira I *et al.,* 2015; Shahbazian M *et al.,* 2009; Simuntis R *et al.,* 2017; Troeltzsch M *et al.,* 2015; Turfe Z *et al.,* 2019; Vestin FM *et al.,* 2017; Wang KL *et al.,* 2015; Yoshiura K *et al.,* 1993). Evaluating the prevalence of periodontal factors, only one study resulted in a higher prevalence of periodontal factors associated with odontogenic sinusitis, showing a percentage of 60% (Bomeli SR, Branstetter BF 4th, Ferguson BJ, 2009). The prevalence of other odontogenic factors has been reported in some studies. The presence of oroantral fistula represented 7.9% to 30% of the total odontogenic MS (Simuntis R *et al.,* 2017; Turfe Z *et al.,* 2019; Wang KL *et al.,* 2015; Yoshiura K *et al.,* 1993).

Three of the selected studies for qualitative analysis evaluated the prevalence of upper teeth involvement associated with odontogenic maxillary sinusitis. The most involved teeth were: maxillary first molar (31.6% -55%);maxillary second molar (33.3% -50%);maxillary second premolar (8% -11.6%); maxillary first premolar (3-7% - 69%);canine (1.7%) and edentulous patients (1.67 %) (Simuntis R *et al.,* 2017; Turfe Z *et al.,* 2019). Allthese data, together with the main characteristics of the included studies, are shown in Table 2. The methodological quality of the studies was evaluated using the Downs and Black Checklist. Most of the studies had scores below 0.50, not meeting most quality items. The main methodological problems found were related to the external and internal validity of the studies, including the lack of a control group, lack of randomness and control of confounding factors (table 2).

DISCUSSION

In several studies included in this systematic review, between 51.8% - 82.3% of MS presented odontogenic causes (Bajoria AA, Sarkar S, Sinha, 2015; Guerra-Pereira *et al.,* 2015; Shahbazian *et al.,* 2009; Troeltzsch *et al.,* 2015; Turfe *et al.,* 2019; Wang *et al.,* 2015; Yoshiura *et al.,* 1993). These results were vastly different from data found in other included studies, in which the odontogenic cause rangedfrom 18.2% to 48% of the etiology of MS (Brazil. Ministério da Saúde, 2014; de Lima *et al.,* 2017; Maillet *et al.,* 2011; Mehra, Jeong, 2019; Vestin *et al.,* 2017). These results differ from reports of the literature in which the incidence of odontogenic MS was estimated between 10% and 12% of all cases of sinusitis (Maloney, Doku, 2019; Mehra, Jeong, 2019). Others odontogenic factors associated with MS were also evaluated. Several studies demonstrated periapical disease as the most common etiology among all odontogenic factors, representing 40% to 94%. These data are opposed to the study conducted by Troeltzsch M *et al.,* 2015, in which endodontics factors represented only 18% of the total odontogenic etiologies of MS. In this same study, iatrogenesis resulting from surgical procedures and dental implants were the odontogenic factorsmost associated with MS, representing 65%.

In the study conducted by Bomeli SR, Branstetter BF 4th and Ferguson BJ, 2009, periodontal disease was the most common etiological factor, representing 60% of the total odontogenic MS. In some studies, the presence of oroantral fistula constituted an etiological factor of odontogenic MS in 2.6%to 28% of the total number of the etiologies Simuntis *et al.,* 2017; Turfe *et al.,* 2019; Yoshiura *et al.,* 1993; Wang *et al.,* 2015). Considering risk factors, several studies included in the qualitative analysis reported a greater association of odontogenic causes withunilateral MS (Turfe Z *et al.,* 2019; Vestin FM *et al.,* 2017; Yoshiura K *et al.,* 1993; Wang KL *et al.,* 2015). This association is corroborated in the study by Yoshiura K *et al.,* 1993, in which odontogenic MS was more frequent in young patients. In a study conducted by Wang KL *et al.,* 2015, 84% of the total odontogenic MS were unilateral. With the result obtained by Troeltzsch M *et al.,* 2015, the authors were able to conclude that most of the cases of unilateral MS (UMS) presented anodontogenic etiology.

Table 1. Main characteristics of included studies

Study	Type of study	Method of examination	Period of collected data	N	% F	Age range	Age (MD)	MS (n1; n2)	Odontogenic (n; %)	Endodontic (n; %)	Periodontal (n; %)	Oroantral fistula (n; %)	Associated tooth (%)
Yoshiura *et al*. (1993)	Retrospective	PA; PAN	1985-1991	68	47,1	NS	46	88 (48; 20)	63 ; 71,6	40; 63,5	11; 17,5	5 (7,9)	NS
Bomeli, Branstetter e Ferguson (2009)	Retrospective	CT	2002-2008	101	42,57	19-94	54,9	124 (78; 23)	102; 82,3	41; 40	61; 60	NS	NS
Maillet *et al*. (2011)	Cross-sectional	CBCT	2006-2008	82	40,2	18-87	57,3	135 (NS; NS)	70; 51,85	NS; NS	NS; NS	NS	U1M(55);U2M(34); U1PM(3); U2PM(8)
Shahbazian *et al*. (2015)	Retrospective	PA; CBCT	2008-2010	145	61,4	20-75	52	60,9 (NS; NS)	41; 67	36; 88	5; 12	NS	NS
Guerra-Pereira *et al*. (2015)	Retrospective	CT	1990-2013	504	55,2	18-82	39,29	250 (NS; NS)	146; 58,4	88; 60	12; 8,2	NS	NS
Troeltzsch *et al*. (2015)	Retrospective	CT; PAN; CBCT; MRI	2006-2013	174	41,4	NS	52,7	174 (NS; NS)	130; 74,7	23; 17,7	13; 10	NS	NS
Wang *et al*. (2015)	Retrospective	CT	2007-2013	3031	NS	NS	55	3031 (NS; NS)	55; 18,2	25; 45	NS; NS	15 (28)	NS
Nunes *et al*. (2016)	Retrospective	CBCT	2009-2013	200	62,5	NS	41,2	NS (NS; NS)	NS; NS	92; NS	NS; NS	NS	NS
Simuntis *et al*. (2017)	Retrospective	PA; PAN	2012-2016	68	64,7	21-60	42	39 (29; 5)	39; 100	37; 94,9	NS; NS	1 (2,6)	U1M(46,15); U2M(33,33); U1PM(7,69); U2PM(12,82)
Vestin Fredriksson *et al*. (2017)	Retrospective	CBCT	2012	303	57,8	NS	49	66 (35; 31)	16; 24,2	15; 93,75	1; 6,25	NS	NS
De Lima *et al*. (2017)	Cross-sectional	CBCT	NS	83	68,7	28-69	41,67	83 (NS; NS)	66; 79,5	42; 63,64	24; 36,4	NS	NS
Ly, Hellgren (2018)	Retrospective	CT	2010-2015	172	57,6	28-89	55	172 (172; 0)	82; 48	NS; NS	NS; NS	NS	NS
Turfe *et al*. (2019)	Prospective	CT	2015-2018	134	41,7	NS	55	134 (NS; NS)	60; 45	40; 66,7	2; 3	18 (30)	U1M(31,6); U2M(50); U3M(3,3); U2PM(11,6); C(1,7), E(1,67)
Bajoria, Sarkar e Sinha (2019)	Retrospective	CBCT	2017-2018	500	37,2	25-65	NS	387 (NS; NS)	191; 49,4	56; 29,32	51; 26,7	NS	NS

N= number of subjects; %F= female subjects percentage; MD= medium; MS= total of affected maxillary sinus; n1= cases of unilateral MS; n2= cases of bilateral MS; PA= Periapical radiography; PAN= Panoramic radiography; TC= Computed Tomography; CBCT= Cone Beam Computed Tomography, MRI= Magnetic Resonance Imaging; NS= non specified; U1M= Upper first molar; U2M= Upper second molar; U3M= Upper third molar; U1PM= Upper first premolar; U2PM= Upper second premolar; C=Canine; E= Edentulous

Table 2. Downs and Black Checklist – Quality evaluation

Article Author & Name	Yoshiura *et al*. (1993)	Bomeli *et al*. (2009)	Maillet *et al*. (2011)	Shahbazian *et al*. (2013)	Guerra-Pereira *et al*. (2015)	Troeltzsch *et al*. (2015)	Wang *et al*. (2015)	Nunes *et al*. (2016)	Simuntis *et al*. (2017)	Vestin Fredriksson *et al*. (2017)	De Lima *et al*. (2017)	Ly, Hellgren (2018)	Turfe *et al*. (2019)	Bajoria *et al*. (2019)
Reporting														
1. Is the hypothesis/aim/objective of the study clearly described?	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3. Are the characteristics of the patients included in the study clearly described?	0	1	0	1	1	1	1	1	1	1	1	1	1	1
4. Are the interventions of interest clearly described?	0	0	0	1	1	1	1	1	1	1	0	1	0	1
5. Are the distributions of principal confounders in each group of subjects to be compared clearly described?	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Are the main findings of the study clearly described?	1	1	1	1	1	1	1	1	1	1	1	1	0	0
7. Does the study provide estimates of the random variability in the data for the main outcomes?	1	1	0	1	0	1	0	1	1	1	0	1	0	0
8. Have all important adverse events that may be a consequence of the intervention been reported?	0	0	0	0	0	0	0	0	1	0	0	0	0	0
9. Have the characteristics of patients lost to follow-up been described?	0	1	0	0	1	1	0	0	0	1	0	0	0	0
10. Have actual probability values been reported (e.g., 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?	0	0	0	0	0	0	0	0	0	1	0	1	0	0
External Validity														
11. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	0	1	0	1	1	1	1	0	0	0	1	1	0	0
12. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	0	1	1	1	1	1	0	1	0	1	0	1	1	1
13. Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?	0	0	0	1	1	1	0	1	0	0	0	0	0	
Internal Validity - Bias														
14. Was an attempt made to blind study subjects to the intervention they have received?	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15. Was an attempt made to blind those measuring the main outcomes of the intervention?	0	0	0	0	0	0	0	0	0	0	0	0	0	0

16. If any of the results of the study were based on "data dredging", was this made clear?	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17. In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in casecontrol studies, is the time period between the intervention and outcome the same for cases and controls?	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18. Were the statistical tests used to assess the main outcomes appropriate?	1	1		1	1	1	1	1	1		1	1	1	0
19. Was compliance with the intervention/s reliable?	0	0	0	1	0	1	0	0	0	0	0	0	0	0
20. Were the main outcome measures used accurate (valid and reliable)?	1	1	1	1	1	1	1	1	1	1	1	0	1	1
Internal Validity - Confounding (selected bias)														
21. Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?	1	1	1	1	1	1	1	1	0	1	0	0	1	1
22. Were study subjects in different intervention groups (trials and cohortstudies)or were the cases and controls (case-control studies) recruited over the same period of time?	0	0	0	0	1	1	0	0	0	0	0	0	0	0
23. Were study subjects randomized to intervention groups?	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24. Was the randomised intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25. Was there adequate adjustment for confounding in the analyses from which the main findingswere drawn?	0	1	0	0	0	0	0	0	0	0	0	0	0	0
26. Were losses of patients to follow-up taken into account?	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Power														
27. Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?	0	1	1	1	1	1	0	1	0	1	0	1	0	1
	4	8	4	9	9	10	6	8	7	9	5	9	4	5
Quality Score: Answered items yes/total of items (27)	0,15	0,30	0,15	0,33	0,33	0,37	0,22	0,30	0,26	0,33	0,19	0,33	0,15	0,19

Association between maxillary sinusitis and periapical diseases: **A systematic review**

Statement of Clinical Relevance: Sinusitis is one of the most common respiratory diseases and presents different etiologies including odontogenic causes. The results of this systematic review highlighted periapical diseases asthe most frequent etiologic factor associated with MS. Considering this fact, endodontic therapy may bethe only choice for treating most cases of odontogenic MS.

Supplemental file 1. Search Strategy

Database	Search strategy
Cochrane	#1 Maxillary sinusitis #2 Rhinosinusitis #3 #1 OR #2 #4 Periapical diseases #5 Odontogenic #6 #4 OR #5 #7 #3 AND #6
Lilacs	(tw:(maxillary sinusitis)) AND (tw:(periapical diseases)) OR (tw:(odontogenic))
Embase	maxillary sinusitis AND periapical diseases
Pubmed	maxillary sinusitis[Text Word]) OR maxillary sinusitis[MeSH Terms]) OR Sinusitis[Text Word]) OR Sinusitis[MeSH Terms]) OR Sinusitides[Text Word]) OR Sinusitides[MeSH Terms]) OR Sinus Infections[Text Word]) OR Sinus Infections[MeSH Terms]) OR Infection, Sinus[Text Word]) OR Infection, Sinus[MeSH Terms]) OR Infections, Sinus[Text Word]) OR Infections, Sinus[MeSH Terms]) OR Sinus Infection[Text Word]) OR Sinus Infection[MeSH Terms]) OR Maxillary Sinusitis[Text Word]) OR Maxillary Sinusitis[MeSH Terms]) OR rhinosinusitis[Text Word]) OR rhinosinusitis[MeSH Terms] AND Periapical Diseases[Text Word]) OR Periapical Diseases[Text Word]) OR Disease, Periapical[Text Word]) OR Diseases, Periapical[Text Word]) OR Periapical Disease[Text Periodontitides, Periapical[Text Word]) OR Periodontitis, Periapical[Text Word]) OR Periodontitis, Apical[Text Word]) OR Apical Periodontitides[Text Word]) OR Apical Periodontitis[Text Word]) OR Periodontitides, Apical[Text Word]) OR Periodontitis, Acute Nonsuppurative[Text Word]) OR Acute Nonsuppurative Periodontitides[Text Word]) OR Acute Nonsuppurative Periodontitis[Text Word]) OR Nonsuppurative Periodontitides, Acute[Text Word]) OR Nonsuppurative Periodontitis, Acute[Text Word]) OR Periodontitides, Acute Nonsuppurative[Text Word]) OR Periapical Abscess[Text Word]) OR Dentoalveolar Abscess, Apical[Text Word]) OR Abscess, Apical Dentoalveolar[Text Word]) OR Abscesses, Apical Dentoalveolar[Text Word]) OR Apical Dentoalveolar Abscess[Text Word]) OR Dentoalveolar Abscesses, Apical[Text Word]) OR Periodontitis, Apical, Suppurative[Text Word]) OR Periapical Periodontitis, Suppurative[Text Word]) OR Periapical Periodontitides, Suppurative[Text Word]) OR Periodontitides, Suppurative Periapical[Text Word]) OR Periodontitis, Suppurative Periapical[Text Word]) OR Suppurative Periapical Periodontitides[Text Word]) OR Suppurative Periapical Periodontitis[Text Word]) OR Alveolar Abscess, Apical[Text Word]) OR Abscess, Apical Alveolar[Text Word]) OR Abscesses, Apical Alveolar[Text Word]) OR Alveolar Abscesses, Apical[Text Word]) OR Apical Alveolar Abscess[Text Word]) OR Apical Alveolar Abscesses[Text Word]) OR Abscess, Periapical[Text Word]) OR Abscesses, Periapical[Text Word]) OR Periapical Abscesses[Text Word]) OR Periapical Granuloma[Text Word]) OR Granuloma, Periapical[Text Word]) OR Granulomas, Periapical[Text Word]) OR Periapical Granulomas[Text Word]) OR Radicular Cyst[Text Word]) OR periapical lesion[Text Word] OR odontogenic[Text Word
Grey Literature	Maxillary sinusitis AND periapical diseases

In a study by Turfe Z *et al.,* 2019, only patients with UMS were evaluated. Among all cases of UMS, 45% of them were attributed to odontogenic causes. This association is extremely relevant because the referred professional can stick to patient's symptoms and suspect a possible odontogenic etiology when these symptoms occur, thus making it more feasible to refer the patientfor appropriate treatment.

It is well established in the literature that there is an intimate relationship between the maxillary sinuses and the root apexes of the maxillary posterior teeth (Lu *et al.,* 1986; Melen *et al.,* 1986). Shahbazian M *et al.,* 2009, evaluated the proximity relationship between the upper posteriorteeth and the floor of the maxillary sinus using periapical radiography and CBCT exams. The maxillary first and second molars showed an intimate relationship to the maxillary sinus floorin 50% and 45%, respectively, when using the CBCT. In this same study, it was demonstrated that periapical radiography was not accurate in determining this relationship, since among all the detected cases of the intimate contact of the teeth with the maxillary sinus by this bidimensional exam, only 58% were confirmed through the CBCT exam (Shahbazian *et al.,* 2009). This result is justified, since the periapical radiography consists of an examination that has limitations such as the overlapping of anatomical structures and does not demonstrate the real spatial perspective of the proximity of the dental roots to the maxillary sinus. According to Bajoria AA, Sarkar S, Sinha P, 2015 and Nunes CA *et al.,* 2017, the CBCT exam is extremely useful in the diagnosis and planning of odontogenic MS. Another study evaluated conventional CT exams for the diagnosis of odontogenic MS and this modality of image examination also proved to be an excellent tool in the diagnostic aid of odontogenic MS. Since CBCT has a good accuracy in the diagnosis of odontogenic MS and generates a much lower dose of ionizing radiation, this type of imaging exam may be more advantageous when compared to the CT (Guerra-Pereira *et al.,* 2015). Among the studies that evaluated the modalities of imaging exams, the study conducted by Simuntis *et al.,* 2017 stands out, which aimed to assess the ability of different professionals (endodontist, oral surgeon, general dentist, otolaryngologist and oral radiologist) to identify the odontogenic etiology of MS through CT exams and, periapical and panoramic radiographs. The oral radiologist showed the best performance among the various professionals. Through the analysis of images examinations, it could be affirmed that CT is more accurate then periapical and panoramic radiographs in diagnosing the dental etiology of MS. Despite the favorable outcome in relation to CT, the authors added that the diagnosis of odontogenic MS does not depend only on the type of image exam, but more specifically on the evaluator who will perform it Simuntis *et al.,* 2017. Due to the proximity of the roots of the upper teeth to the maxillary sinuses, once these teeth have infections, they can affect the maxillary sinuses. Among the studies included in the qualitative analysis of this systematic review, three evaluated which teeth were most affected by odontogenic MS. The most affected teeth were the upper first molars (31.6% -55%), the upper second molars (33.3% -50%) and the upper second premolars (8-12.8%), while the palatal root of the upper first molars was the root most associatedwith odontogenic MS (Maillet *et al.,* 2011; Mehra, Jeong, 2019; Simuntis *et al.,* 2017; Turfe *et al.,* 2019). Odontogenic causes arequitecommon in UMS. Despite this association, odontogenic etiologies are often overlooked by general practitioners and otorhinolaryngologists, sincethe odontogenic etiology may not be seen in radiographic examinations. It is suspected that there is a lack of knowledge on the part of professionals in relation to association of dental etiologies with MS. de Lima CO *et al.,* 2017 and Wang KL *et al.,* 2015 concluded that MS should be approached in a multidisciplinary manner and cite that the interaction between otolaryngologists and oral surgeons can be extremely beneficial to patients with suspicions of odontogenic MS .

CONCLUSION

The present systematic review showed a high prevalence of periapical diseases as the main etiology of MS. Most studies analyzed indicated endodontic factors as the most common cause, with a prevalence ranging from 18% to 94.9%. Thus, we emphasize the importance of this fact for the endodontist, since the upper posterior teeth may have an intimate relationship with the maxillary sinuses. Once these teeth are affected by periapical disease, this type of disease can progress to MS. Misdiagnosis of an odontogenic etiology of MS can lead to inadequate treatment without solving the root cause of the problem.

REFERENCES

Bajoria AA, Sarkar S, Sinha P. (2015) Evaluation of odontogenic maxillary sinusitis with cone beam computed tomography: A retrospective study with review of literature. J Int Soc Prevent Communit Dent,9, 194-204.

Bomeli SR, Branstetter BF 4th, Ferguson BJ. (2009) Frequency of a dental source for acute maxillary sinusitis. Laryngoscope,119, 580-4.

Brook I. (2006) Sinusitis of odontogenic origin. Otolaryngol Head Neck Surg, 135, 349–55. beam computed tomography scanning: a retrospective study. *J Endod*,38, 1069-74.

de Lima CO, Devito KL, Baraky Vasconcelos LR, Prado MD, Campos CN. (2017) Correlation between endodontic infection and periodontal disease and their association with chronic sinusitis: a clinical-tomographic study. J Endod,43, 1978-83.

Downs S, Black N. (2009) The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions J Epidemiol Community Health,52,377-84.

Goller-Bulut D, Sekerci AE, Kose E, et al. (2013) Cone beam computed tomographic analysis of maxillary premolars and molars to detect the relationship between periapical and marginal bone loss and mucosal thickness of maxillary sinus. Med Oral Patol Oral Cir Bucal,20, 572-9.

Guerra-Pereira I, Vaz P, Faria-Almeida R, Braga AC, Felino A. (2015) CT maxillary sinus evaluation--A retrospective cohort study. Med Oral Patol Oral Cir Bucal,20, 419-26.

Hoskison E, Daniel M, Rowson JE, Jones NS. (2003) Evidence of an increase in the incidence of odontogenic sinusitis over the last decade in the UK. J Laryngol Otol,126, 43-46.

Huntzinger A. (2007) Guidelines for the Diagnosis and Management of Rhinosinusitis in Adults. Am Fam Physician,76, 1718-17.

Kretzschmar DP, Kretzschmar JL. (2003) Rhinosinusitis: review from a dental perspective. Oral Surg Oral Med Oral Pathol Oral Radiol Endod,96, 128-35.

Legert KG, Zimmerman M, Stierna P. (2003) Sinusitis of odontogenic origin: Pathophysiological implications of early treatment. Acta Otolaryngol. 124, 655-663.

Lu Y, Liu Z, Zhang L, et al. (1986) Associations between maxillary sinus mucosal thickening and apical periodontitis using cone-beam computed tomography scanning: a retrospective study. J Endod,38, 1069-74.

Ly D, Hellgren J. (2018) Is dental evaluation considered in unilateral maxillary sinusitis? A retrospective case series. Acta Odontol Scand,76, 600-4.

Maillet M, Bowles WR, McClanahan SL, John MT, Ahmad M. Cone-beam computed tomography evaluation of maxillary sinusitis. (2011) J Endod,37, 753-7.

Maloney PL, Doku HC. Maxillary sinusitis of odontogenic origin. (2019) J Can Dental Assoc (Toronto), 34,591-603.

Mehra M, Jeong D. (2019) Maxillary sinusitis of odontogenic origin. Curr Infect Dis Rep, 10, 205-9.

Melen I, Lindahl L, Andreasson L, Rundcrantz H. (1986) Chronic maxillary sinusitis. Definition, diagnosis and relation to dental infections and nasal polyposis. Acta Otolaryngol, 101, 320-327.

Metodológicas, D. (2014). elaboração de revisão sistemática e metanálise de estudos de acurácia diagnóstica. Ministério Da Saúde. Secretaria de Ciência, Tecnologia e Insumos Estratégicos. Departamento de Ciência e Tecnologia. Brazil.

Moher D, Liberati A, Tetzlaff J, et al. (2009) Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement (Chinese edition). J Chinese Integr Med,7, 889-96.

Nunes CA, Guedes OA, Alencar AH, Peters OA, Estrela CR, Estrela C. (2017) Evaluation of periapical lesions and their association

with maxillary sinus abnormalities on cone-beam computed tomographic images. J Endod,42, 42-6.

Nurbakhsh B, Friedman S, Kulkarni GV, Basrani B, Lam E. (2003) Resolution of maxillary sinus mucositis after endodontic treatment of maxillary teeth with apical periodontitis: a cone-beam computed tomography pilot study. J Endod,37, 1504-11.

Shahbazian M, Vandewoude C, Wyatt J, Jacobs R. (2009) Comparative assessment of periapical radiography and CBCT imaging for radiodiagnostics in the posterior maxilla. Odontology,103, 97-104.

Shanbhag S, Karnik P, Shirke P, et al. (2013) Association between endodontic infection and maxillary sinus mucosal thickening: a retrospective cone-beam computed tomographic study. J Endod,39, 853-7.

Sheikhi M, Pozve NJ, Khorrami L. (2013) Using cone beam computed tomography to detect the relationship between the periodontal bone loss and mucosal thickening of the maxillary sinus. Dent Res J (Isfahan),11, 495-501.

Simuntis R, Kubilius R, Padervinskis E, Ryškienė S, Tušas P, Vaitkus S. (2017) Clinical efficacy of main radiological diagnostic methods for odontogenic maxillary sinusitis. Eur Arch Otorhinolaryngol,274, 3651-58.

Troeltzsch M, Pache C, Troeltzsch M, et al. (2015) Etiology and clinical characteristics of symptomatic unilateral maxillary sinusitis: a review of 174 cases. J Craniomaxillofac Surg, 43, 1522-9.

Turfe Z, Ahmad A, Peterson EI, Craig JR. (2019) Odontogenic sinusitis is a common cause of unilateral sinus disease with maxillary sinus opacification. Int Forum Allergy Rhinol, 9, 1515-20.

Vestin Fredriksson M, Ohman A, Flygare L, Tano K. (2017) When maxillary sinusitis does not heal: findings on CBCT scans of the sinuses with a particular focus on the occurrence of odontogenic causes of maxillary sinusitis. Laryngoscope Investig Otolaryngol, 2, 442-6.

Wang KL, Nichols BG, Poetker DM, Loehrl TA. (2015) Odontogenic sinusitis: a case series studying diagnosis and management. Int Forum Allergy Rhinol,5, 597-601.

Yoshiura K, Ban S, Hijiya T, et al. (1993) Analysis of maxillary sinusitis using computed tomography. Dentomaxillofac Radiol, 22, 86-92.

****