Computed tomography-based assessment of odontogenic sinusitis diagnosis: a cross-sectional study

Avaliação baseada na tomografia computadorizada do diagnóstico de sinusite odontogênica: um estudo transversal

Received: 2023-11-15 | Accepted: 2023-12-18 | Published: 2023-12-22

Amanda Regina Fischborn
ORCID: orcid.org/0000-0002-7470-484X
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: amandafischborn@hotmail.com

Flamarion de Barros Cordeiro
ORCID: orcid.org/0000-0002-3929-3985
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
Email: flamacordeiro@uol.com.br

Caique Mariano Pedroso
ORCID: orcid.org/0000-0002-7504-7597
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: caiqueumar@gmail.com

Gabriella Schmitz Oliveira
ORCID: orcid.org/0000-0002-0312-9494
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: gabriella.schm@gmail.com

Fabio Brasil de Oliveira
ORCID: orcid.org/0000-0002-9207-8694
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: fabio.brasil.oliveira@gmail.com

Jessica Daniela Andreis
ORCID: orcid.org/0000-0002-4435-4850
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: autoria@email.com

Lea Rosa Chioca Ferro
ORCID: orcid.org/0000-0002-3990-7852
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: leachioca@hotmail.com

Marcelo Carlos Bortoluzzi
ORCID: orcid.org/0000-0003-2756-5047
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: m.bortoluzzi@gmail.com

Marcela Claudino
ORCID: orcid.org/0000-0003-1553-5852
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: marcelaclaudino@hotmail.com

Gilson Cesar Nobre Franco
ORCID: orcid.org/0000-0001-7082-7837
Departamento de Odontologia, Universidade Estadual de Ponta Grossa, Brasil
E-mail: gilsoncnf@gmail.com
ABSTRACT

Odontogenic sinusitis remains still underdiagnosed by dental and medical radiologists, and to date, there are no guidelines to make the correct diagnosis. This study aimed to evaluate the prevalence of odontogenic sinusitis on computed tomography in patients indicated to the assessment of maxillary sinusitis in the medical setting. A cross-sectional study was outlined between 2017 to 2019. The DICOM files of patients that performed computed tomography to assess the hypothesis of maxillary sinusitis were evaluated. The maxillary sinusitis was classified following the absence of sinusitis, non-odontogenic sinusitis, odontogenic sinusitis, and indeterminate sinusitis. Odontogenic sinusitis was classified concerning the origin as an endodontic factor, periodontal disease, and dental foreign body. Forty-three patients with a mean age of 47.46±17.77 (ranging from 18 to 98) years old that tomographic presented evidence of maxillary sinusitis was included in this study. Considering the sample (n=43), 23.25% (n=10) of patients had maxillary sinusitis of odontogenic origin and 90% of odontogenic cases were associated with endodontic lesions. We observed a high prevalence in computed tomography for odontogenic sinusitis. The presence of periapical alteration associated with endodontic factors was the most prevalent dental origin.

Keywords: Maxillary sinusitis; Tomography; Tooth diseases; Diagnosis; Infections.

RESUMO

A sinusite odontogênea ainda é subdiagnosticada por radiologistas odontológicos e médicos e, até o momento, não há diretrizes para fazer o diagnóstico correto. Este estudo teve como objetivo avaliar a prevalência de sinusite odontogênea na tomografia computadorizada em pacientes indicados para a avaliação de sinusite maxilar no ambiente médico. Foi delineado um estudo transversal entre 2017 e 2019. Foram avaliados os arquivos DICOM de pacientes que realizaram tomografia computadorizada para avaliar a hipótese de sinusite maxilar. A sinusite maxilar foi classificada de acordo com a ausência de sinusite, sinusite não odontogênea, sinusite odontogênea e sinusite indeterminada. A sinusite odontogênea foi classificada quanto à origem como fator endodôntico, doença periodontal e corpo estranho dentário. 43 pacientes com idade média de 47.46±17.77 (variando de 18 a 98) anos que apresentavam evidências tomográficas de sinusite maxilar foram incluídos neste estudo. Considerando a amostra (n=43), 23,25% (n=10) dos pacientes apresentavam sinusite maxilar de origem odontogênea e 90% dos casos odontogênicos estavam associados a lesões endodônticas. Observamos uma alta prevalência na tomografia computadorizada para sinusite odontogênea. A presença de alteração periapical associada a fatores endodônticos foi a origem dentária mais prevalente.

Palavras-chave: Sinusite maxilar, Tomografia; Doenças dentárias; Diagnóstico; Infecções.
INTRODUÇÃO

Sinusitis, representada por uma doença multifatorial, é um estado inflamatório crônico das estruturas situadas no paranasal, incluindo frontais, esfenoides, etmoides, e sinus maxilares (Workman et al., 2018). Particularmente no maxilar, a sinusite é tipicamente classificada como não-odontogênica e odontogênica, e representa extensão de morbidade e alto custo associado aos serviços de saúde, o que impacta na elevação de consultas médicas e uso de medicamentos anti-inflamatórios para tratamento (Workman et al., 2018; Wang et al., 2015).

Odontogênica sinusitis (OS) é um subtipo de inflamação crônica que tem uma prevalência geral variando de 10 a 40% na população mundial (Workman et al., 2018; Wang et al., 2015; Wuokko-landen et al., 2019). OS tem uma predileção feminina leve e é comumente diagnosticado entre a quarta e a sexta década de vida (Zirk et al., 2017). A sinusite tem uma origem odontogênica quando a mucosa dos sinus é maior do que 2 milímetros de espessura e está associada a uma área de dentes com alterações (Vidal et al., 2017; Capelli et al., 2016; Maillet et al., 2011). Os principais fatores etiológicos relacionados ao desenvolvimento de sinusite odontogênica envolvem inflamações periapicais da infecção do tecido pulpário e a presença de corpos estranhos no maxilar, incluindo restos radiculares e implantes dentários (Wuokko-landen et al., 2019). Além disso, a perda óssea severa causada por doença periodontal também pode ser considerado um fator etiológico potencial do odontogênica sinusitis (Tataryn et al., 2018). Esses fatores podem afetar a membrana sinusial (membrana Schneiderian) resultando em complicações patológicas no maxilar (Wang et al., 2015; Nascimento et al., 2016).

Considerando a causa da sinusite, existem diferenças na patofisiologia, microbiologia, diagnóstico, e tratamento, mesmo que os sintomas sejam similares (Workman et al., 2018). A confusão diagnóstica leva a falhas no tratamento e pode progredir a complicações graves como infecções craniofaciais com risco de morte (Vidal et al., 2017). Para realizar um diagnóstico de OS, o uso de imagens bidimensionais como radiografias intraorais e panorâmicas apresenta eficácia limitada, que dificulta o exame das estruturas sinusinares no contexto tridimensional (Shahbazian et al., 2012; Simuntis et al., 2017). Assim, a utilização de tomografia computadorizada (CT) e cone-beam computadographic tomography (CBCT) são os métodos de referência para o diagnóstico de sinusite, avaliando detalhadamente o sistema paranasal e as estruturas dentárias possivelmente envolvidas (Simuntis et al., 2017; Capelli et al., 2016).
Although the high prevalence, OS remains still underdiagnosed by dental and medical radiologists, and to date, there are no guidelines to make the correct diagnosis. Challenges in OS diagnosis by medical professionals might difficult the early sinusitis diagnosis and the respective knowledge about the principal etiologic factor. Therefore, this study aimed to evaluate the prevalence of odontogenic sinusitis through CT in patients that were referred to a clinical diagnosis of sinusitis in the medical setting.

MATERIAL AND METHODS

Sample selection

This cross-sectional study was approved by the Research Ethics Committee (State University of Ponta Grossa 3.187.087). The convenience sample of this study included medical records and DICOM (Digital Imaging Communications in Medicine) files of fifty patients, older than 18 years, referred for computed tomography scans of the maxillary sinus region with a clinical indication for sinusitis assessment in the period between 2017 to 2019. Data from seven patients were excluded due to the presence of imaging signs of surgical procedures in the region to be evaluated (n=3) and technical problems with DICOM files (n=4). Overall, 43 DICOM files of patients were included (Figure 1).

Figure 1 – Schematic representation of study flowchart.
Image acquisition and analysis

Imaging exams were acquired using a Philips® tomograph, model 16 channels 454110120021 (Royal Philips®, Amsterdam/Netherlands), and a Neusoft® tomograph, model 16 channels 454110120031 (Neurosoft Medical Systems®, Shenyang / China). The analysis of the images in DICOM format was performed using the RadiAnt™ DICOM Viewer software (Medixant®, Poznan/Poland) with a 23mp55, 23 inch, LPS LED monitor (LG Corporation®, Seoul / Korea South) in a room with brightness control. All evaluations were performed by a single, calibrated, and blinded examiner (intra-examiner Kappa coefficient value 0.895).

Sinusitis classification

Sinusitis was evaluated according to the adapted classification proposed by Maillet et al. (2011) considering the thickening of the sinus mucosa and the presence of local dental alterations in the maxillary sinus. The images were classified following the absence of sinusitis, non-odontogenic sinusitis, odontogenic sinusitis, and indeterminate sinusitis (Table 1 and Figure 2). Cases of odontogenic sinusitis were further evaluated and classified according to the dental-specific etiology as endodontic or periodontal disease and dental foreign body (Table 2 and Figure 2).

Table 1. Sinusitis classification according to the origin (Adapted from Maillet et al., 2011)

<table>
<thead>
<tr>
<th>Sinusitis classification</th>
<th>Characteristics of the sinus mucosa</th>
<th>Local dental characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of sinusitis (Figure 2a)</td>
<td>Absence of thickening or thickening less than 2 mm</td>
<td>No local dental changes</td>
</tr>
<tr>
<td>Non-odontogenic sinusitis (Figure 2b)</td>
<td>Thickening greater than 2 mm, non-limited to a specific region or polypoid lesion</td>
<td>No local dental changes</td>
</tr>
<tr>
<td>Odontogenic sinusitis (Figure 2c)</td>
<td>Thickening greater than 2 mm, limited to a specific region</td>
<td>Teeth changed / Periapical lesion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dental foreign bodies Severe bone loss</td>
</tr>
<tr>
<td>Undetermined sinusitis (Figure 2d)</td>
<td>Thickening greater than 2 mm, non-limited to a specific region</td>
<td>Teeth changed / Periapical lesion Dental foreign bodies Severe bone loss</td>
</tr>
</tbody>
</table>

**Figure 2.** Representative scheme of TC characteristics regarding the origin of sinusitis

**Table 2.** Odontogenic sinusitis classification according to the dental etiology

<table>
<thead>
<tr>
<th>Dental etiology</th>
<th>Characteristics of the sinus mucosa</th>
<th>Local dental characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endodontic disease (Figure 2e / 2f)</td>
<td>Thickening greater than 2 mm, limited to a specific region</td>
<td>Presence of hypodense image in the periapical region of the tooth with or without endodontic treatment</td>
</tr>
<tr>
<td>Periodontal disease</td>
<td>Thickening greater than 2 mm, limited to a specific region</td>
<td>Presence of alveolar bone loss, extending more than two-thirds of</td>
</tr>
</tbody>
</table>
Figure 2g: the length of the root or in the root furcation region

<table>
<thead>
<tr>
<th>Dental foreign bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickening greater than 2 mm, limited to a specific region</td>
</tr>
<tr>
<td>Sinus presence of dental foreign bodies, including dental implants, root remnants, and endodontic material</td>
</tr>
</tbody>
</table>

(Figure 2h)

Statistical analysis

Descriptive statistical analysis was performed by Prism 7.0 (GraphPad Software Inc., EUA) to describe demographic characteristics according to gender and age. Descriptive statistics included the mean and standard deviation (M±SD) for continuous variables and numbers and percentages of the total for categorical and ordinal variables.

RESULTS

Forty-three participants (medical reports and CT DICOM files) were included in this study (Table 3). The mean age was 47.46±17.77 ranging from 18 to 98 years. 19 males (40.91±17.03 years) and 24 females (55.73±15.00 years) were included. All patients that underwent CT assessment had imaging alterations.

Table 3. Demographic characteristics of patients according to gender and age.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Total number (%)</th>
<th>Average age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>19 (44.20%)</td>
<td>40.91</td>
</tr>
<tr>
<td>Female</td>
<td>24 (55.80%)</td>
<td>55.73</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-20</td>
<td>2 (4.65%)</td>
<td>18.50</td>
</tr>
<tr>
<td>21-40</td>
<td>12 (27.90%)</td>
<td>29.00 ± 0.50</td>
</tr>
<tr>
<td>41-60</td>
<td>19 (44.20%)</td>
<td>49.68 ± 6.48</td>
</tr>
<tr>
<td>61-80</td>
<td>9 (20.93%)</td>
<td>68.22 ± 5.29</td>
</tr>
<tr>
<td>80+</td>
<td>1 (2.32%)</td>
<td>98.00 ± 0</td>
</tr>
<tr>
<td>Total</td>
<td>43 (100%)</td>
<td>47.46</td>
</tr>
</tbody>
</table>

Based on tomographic characteristics of sinusitis, 30 cases (69.77%) were of non-odontogenic origin; 10 cases (23.25%) were of odontogenic origin, and 3 cases (6.98%) were of undetermined origin (Figure 3). Regarding maxillary sinusitis with an odontogenic origin, 9 cases (90%) were associated with endodontic factors. Seven cases
(70%) were observed teeth without endodontic treatment and two cases (20%) were observed teeth with endodontic treatment, suggesting possible clinical failure. One case (10%) was associated with a dental foreign body (residual root). No case of odontogenic sinusitis was associated with periodontal disease, and all cases of OS were unilateral.

![Figure 3](image)

**Figure 3.** Prevalence of sinusitis caused by odontogenic, non-odontogenic, and undetermined origin.

**DISCUSSION**

The relationship between odontogenic disorders and the presence of chronic sinusitis has received attention due to the possibility of dental origin. Indeed, the OS prevalence has shown a significant increase, particularly as a result of indications of three-dimensional imaging tests use such as CT and CBCT, which were underestimated in the past (Newsome et al., 2020). These imaging modalities are reliable and highly accurate strategies for evaluating the maxillary sinuses and adjacent structures (Nascimento et al., 2016; Newsome et al., 2020; Lechien et al., 2014). In addition, further detailed clinical examination focusing on etiological factors might be associated with an increase in OS prevalence (Newsome et al., 2020). In this context, this study aimed to evaluate the OS prevalence through CT in patients with a clinically suspicious diagnosis of sinusitis.

The prevalence of OS observed in our paper (23.5%) followed previous studies that described that odontogenic factor is implicated in 10% to 40% of sinusitis cases (Workman et al., 2018; Wang et al., 2015). It is important to consider whether sinusitis has a unilateral or bilateral profile concerning etiological factors since lesions of odontogenic origin tend to present mostly in a unilateral profile that is similar to our data.
Patel et al., 2012; Troeltzsch et al., 2015). Odontogenic infection involvement has been implicated in approximately 70% of cases of unilateral paranasal sinusitis; however, it is not exclusively because recent studies have reported the occurrence of bilateral OS (Matsumoto et al., 2015; Pokorny et al., 2013). In computed tomography, OS findings are represented as unilateral maxillary sinus opacification and the presence of overt maxillary dental pathology (Craig JR, 2022). To final diagnosis, the interrelation between medical and dentists is critical to classify and confirm the cause of this condition, in order to minimize further complications (Wuokko-Landen et al., 2021).

Radiograph diagnostic classification considered the mucosal thickness as a parameter to verify the association between odontogenic cause and sinusitis in the maxillary sinus (Di Girolamo et al., 2022). To odontogenic etiology, the classification contemplated a mucosal thickness greater than five millimeters and less than two millimeters is considered a normal sinus (Di Girolamo et al., 2022). In this context, the radiograph classifications of OS are heterogeneous in the literature and most remain not to include a multidisciplinary assessment (Allevi et al., 2021). Medical and dentist specialists are the health professionals able to conduct the OS diagnosis through the presentation of clinical features. When sinusitis is suspicious, health professionals should investigate with a radiograph, intraoral exams, and nasal endoscopy, to find the presence of infection and dental pathology (Craig JR, 2022). A decayed tooth, a defective restoration, or extraction site with or without radiographically evident periapical lesion and mucosal thickening limited to tooth location are features that imply in OS diagnosis (Maillet et al., 2011). Furthermore, purulence, edema, polyps, intraoral fistula, pulpal necrosis arising from dental caries, and periodontal disease are clinical findings that may confirm the OS diagnosis (Craig JR, 2022). Due to pulpal necrosis, pain is not common, and the lack of painful symptoms might advance to a delay in diagnosis. Therefore, the interrelation between medical and dentists is crucial to delimit the possible causes related to OS and to decrease the misdiagnosis time.

The use of CT might be considered a limitation of our study. Although CBCT is more precise and has been used more than CT to visualize the maxillary sinus structures, to date, there is no evidence of which tomography technique is more accurate for OS diagnosis. Several medical centers and hospitals did not have the opportunity to use CBCT as well as dental centers. The limitation of CBCT use exclusively in hospitals could increase the health costs associated contributing to misdiagnosis time and advance of maxillary infection. CT use must be still recommended for OS diagnosis by a
multidisciplinary team, to interpret imaging studies and facilitate the recognized cause of this disease.

The cause of OS may include endodontic disease from pulpal necrosis, periodontitis, oroantral communication or fistula, and dental-treatment-related foreign bodies within the maxillary sinus (Craig JR, 2022). Our findings showed pulp infections and the presence of a foreign body without periodontal-related disease. Endodontic disease is a common cause of OS with 73% of cases diagnosed in which start with bacterial invasion of the pulp space causing pulpitis and pulpal necrosis (Yoshiura et al., 1993; Hoskison et al., 2012). In addition, iatrogenic procedures are considered the main cause of OS followed by apical periodontal pathologies (Lofthag-Hansen et al., 2007). In this perspective, the guide of the American Association of Endodontists affirms the importance of distinguishing the etiologies of sinusitis of odontogenic origin, due to the difference that each one requires in clinical conduct (Tataryn et al., 2018). Occasionally, dental treatment alone is adequate to resolve the OS, and concomitant or subsequent surgical procedures may be required (Newsome et al., 2020). To provide adequate treatment, routine assessment of the patient's dental history and status, careful tomograph evaluation, and utilization of microbial findings should be performed (Wuokko-Landen et al., 2021).

Our results demonstrate the potential involvement of dental disorders in the etiology of sinusitis. To date, the OS prevalence has still been under-reported leading to difficulty in recognizing etiological factors (Bajoria et al., 2019). Routine dental evaluation in patients with risk factors should be implemented to provide adequate treatment, once the treatment and prognosis are strongly related to the establishment of an assertive diagnosis. Thus, CT is a relevant strategy for the diagnosis of sinusitis associated with clinical examination. Further studies should be performed in the OS field, to improve the classification, diagnosis, and treatment of this condition, especially to support adequate acknowledgment to medical and dentists in the clinical setting.

CONCLUSION

This study indicates a relatively high odontogenic sinusitis prevalence characterized by computed tomographic evaluation. Periapical alteration associated with endodontic factors was the most prevalent dental origin and must be considered a risk factor for odontogenic sinusitis.
REFERÊNCIAS


Hoskison E, Daniel M, Rowson JE, Jones NS. Evidence of an increase in the incidence of odontogenic sinusitis over the last decade in the UK. J Laryngol Otol. 2012;126:43-6.


