PRECISION OF THE ANALYSIS OF THE MAXILLARY SINUS AND ITS PATHOLOGIES BY PANORAMIC RADIOGRAPHY

PRECISÃO DA ANÁLISE DOS SEIOS MAXILARES E SUAS PATOLOGIAS POR RADIOGRAFIA PANORÂMICA

PRECISIÓN DE ANÁLISIS DE LOS SENOS MAXILARES Y SUS PATOLOGÍAS POR RADIOGRAFÍA PANORÁMICA

Ana Valéria da Silva Nogueira[1], Sérgio Antonio Pereira Freitas[2], Gabriel Juscelino Feitosa da Silva[3], Sarah Jane de Araújo Barros[4], Carla Maria de Carvalho Leite[5]

1 – Centro Universitário UNINOVAFAPI. Undergraduate in Dentistry. E-mail: anavaleria_sn@hotmail.com
2 – Centro Universitário UNINOVAFAPI. PhD in Dentistry. E-mail: sergioxray@hotmail.com
3 – Centro Universitário UNINOVAFAPI. Undergraduate in Dentistry. E-mail: bieljuscelino@hotmail.com
4 – Centro Universitário UNINOVAFAPI. PhD in Legal and Social Sciences. E-mail: sjanebarros@gmail.com
5 – Centro Universitário UNINOVAFAPI. PhD in Dentistry. E-mail: carla.anatomia@gmail.com

Ana Valéria da Silva Nogueira (Corresponding author)
Centro Universitário UNINOVAFAPI. Undergraduate student in Dentistry.
E-mail: anavaleria_sn@hotmail.com

ABSTRACT

Objective: Evaluate the accuracy of panoramic radiographs in presenting findings in maxillary sinuses. **Materials and methods**: The survey consisted of 126 panoramic radiographs collected in two diagnostic imaging clinics. Examined by 3 evaluators, data collect they were tabulated in Excel and applied the Chi-square test. **Results:** The panoramic radiography had a total of 187 (49,46%) correct diagnoses, 91 (24.7%) on the right side and 96 (25.39%) on the left side. The results showed that the panoramic radiograph is not adequate as a diagnostic tool for the maxillary sinuses, since there is a statistically significant difference with p <0.0001. **Conclusion:** It was possible to find the same variety of findings and sinus pathologies as the CBCT, but the amount of adjustment in general by examination was quite different. Thus, panoramic radiography does not present the same precision in the analysis of pathologies and sinus findings when compared to concomitant computed tomography.
Keywords: Maxillary sinus. Panoramic ragiography. Cone beam computed tomography.

RESUMEN

Objetivo: Evaluar la precisión de las radiografías panorámicas en presentar hallazgos en senos maxilares. **Materiales y métodos**: La investigación fue compuesta por 126 radiografías panorámicas recogidas en dos clínicas de diagnóstico por imagen. Se examinaron por 3 evaluadores, los datos fueron tabulados en Excel y aplicó la prueba Chi-cuadrado. **Resultados:** La radiografía panorámica presentó un total de 187 (49,46%) diagnósticos correctos, siendo 91 (24,07%) del lado derecho y 96 (25,39%) lado izquierdo. Los resultados mostraron que la radiografía panorámica no se presenta adecuada como medio de diagnóstico de los senos maxilares, ya que existe una diferencia estadísticamente significativa con p<0,0001. **Conclusión:** Fue posible encontrar la misma variedad de hallazgos y patologías sinusales que la TCFC, pero la cantidad de acierto en el general por examen fue bastante diferente. De esta forma, la radiografía panorámica no presenta la misma precisión en el análisis de las patologías y hallazgos sinusales cuando comparada la tomografía computarizada de haz cónico.
Descriptores: Senos maxilares. Radiografías panorâmicas. Tomografía computarizada de haz cónico

RESUMO

Objetivo: Avaliar a precisão das radiografias panorâmicas em apresentar achados em seios maxilares. **Materiais e métodos:** A amostra foi composta por 126 radiografias panorâmicas e tomografias computadorizadas de feixe cônico (TCFC) de maxila (padrão-ouro) coletadas em duas clínicas de diagnóstico por imagem na cidade de Teresina (PI). Foram examinadas por 3 avaliadores, os dados foram tabulados em Excel e aplicado o teste Qui-quadrado. **Resultados**: A radiografia panorâmica apresentou um total de 187 (49,46%) diagnósticos corretos, sendo 91 (24,07%) do lado direito e 96 (25,39%) do lado esquerdo. Os resultados mostraram que a radiografia panorâmica não é adequada como meio de diagnóstico dos seios maxilares, uma vez que existe diferença estatisticamente significativa (p<0,0001) entre seus achados e o padrão-ouro. **Conclusão**: Foi possível encontrar em radiografias panorâmicas a mesma variedade de achados e patologias sinusais que na TCFC, porém a quantidade de acertos no geral por exame foi bastante diferente.
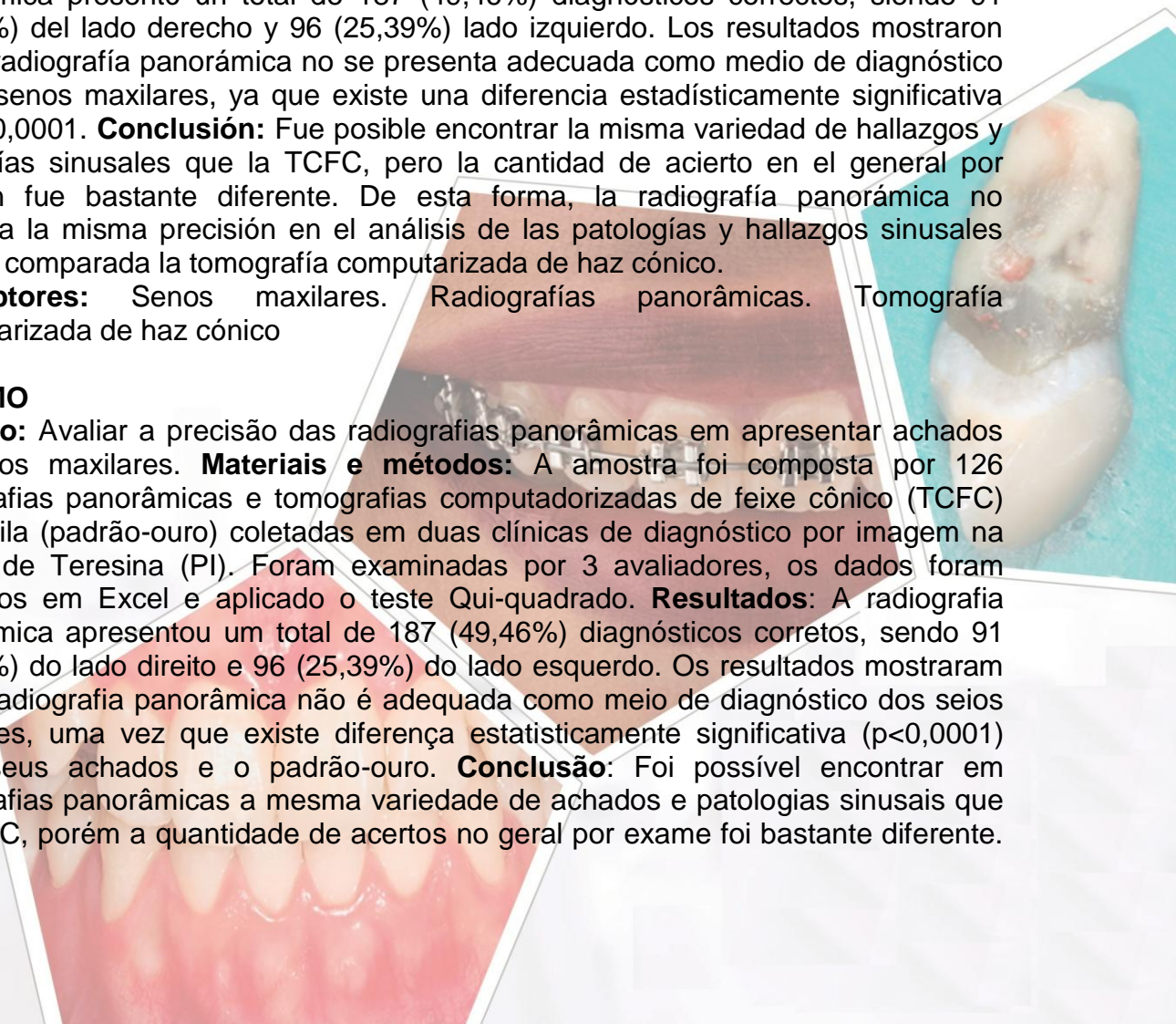
Dessa forma, radiografia panorâmica não apresenta a mesma precisão na análise das patologias e achados sinusais quando comparada a tomografia computadorizada de feixe cônico.

Descritores: Seio maxilar. Radiografia panorâmica. Tomografia computadorizada de feixe cônico

Introduction

Dentistry is a health area that aims not only care related to the mouth, the functional masticatory condition and the teeth. Oral health goes beyond these aspects, and it must be considered factors and structures that are in direct relation or not with the oral cavity. As an example there are the maxillary sinuses, anatomical structures that are part of a set of sinuses of the face, called paranasal sinuses.[1]

The maxillary sinuses are pneumatic spaces that play an important role in the maintenance of homeostasis, and present themselves as relevant structures in a dental evaluation due to its proximity to the alveolar process of the maxilla. These structures may develop inflammatory reactions resulting from infections of the upper airways by viruses, bacteria, fungi and, contiguity with periapical lesions associated with maxillary teeth.[1-2]

This relationship of proximity to the alveolar process of the maxilla can lead to sinus affections due to periapical lesions, pulp necrosis, oral-sinusal communication, periodontal abscess, extensive carious lesion, among other factors. Due to the proximity of dental structures and maxillary sinuses, inflammatory diseases, as well as neoplastic and tumor lesions affecting this region, are common incidental findings in this area when the radiographic evaluation is performed and should therefore be carefully analyzed.[1,3]

In dental practice, performing clinical and radiographic evaluation of patients is a major concern of dentists. Depending on the specificity and severity of each patient's case, it may be necessary to request examinations such as panoramic radiography and concomitant computed tomography (CT), which are usually pre-treatment examinations. Panoramic radiography is routinely requested by dental surgeons for providing an image of the middle and lower thirds of the face. However, this image presents a great overlap of structures, limiting its use for the diagnosis of certain pathologies.[4]

On the other hand, concomitant computed tomography (CT) represents one of the major advances in dental radiology, representing a quality standard for providing three-dimensional images, anatomical sections that do not present overlaps, easy identification and location of structures and different pathologies, offering diagnostic information. This imaging test represents a gold standard in the identification of alterations present in the maxillary sinuses.[5]

Panoramic radiography is the most requested complementary examination prior to dental treatment, a fact that may limit the diagnosis of anatomical correlation between dental roots and alveolar bone, as well as incidental findings in the breasts.[6]

The proximity of the maxillary sinuses to the alveolar process of the maxilla can be visualized both by panoramic radiographs and by CBCT. However, there is still no consensus on whether it is possible to clearly identify the same changes in the two exams, and there is doubt about the accuracy of the panoramic radiographs in showing alterations in the maxillary sinuses.[6]
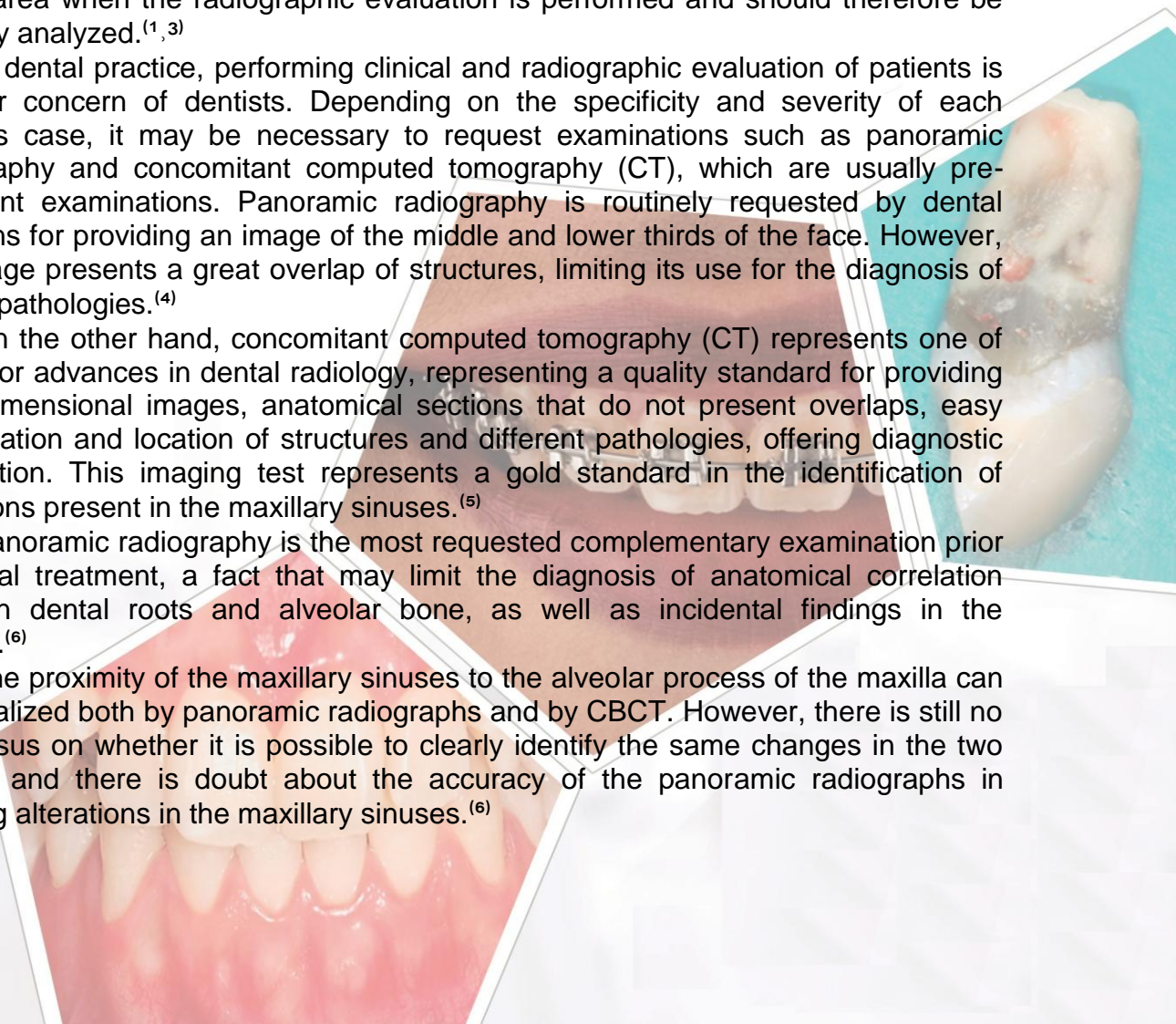
The objective of this study was to evaluate the precision of the panoramic radiographs in presenting findings in the maxillary sinuses.

Materials and methods

The research consisted of a retrospective observational study conducted in the database from 2015 to July 2018 in two diagnostic imaging clinics in the city of Teresina (PI). We selected patients who underwent concomitant computed tomography (CT) scan of the maxilla and panoramic radiographs on the same day. The present research was submitted and approved in the Ethics and Research Committee of Uninovafapi (opinion 2,862,081).

Assuming a margin of error of 5% and assuming the expected prevalence of 82% of maxillary sinus findings, an initial sample of 227 patients was obtained. Of these, only 126 met the inclusion and exclusion criteria: Patients who had concomitant computed tomography (CT) scans of the maxilla and panoramic radiography performed on the same day were included, and the others were excluded; Only included patients over 12 years of age; Excluded only exams within the period from 2015 to July 2018, excluding the others.

A total of 117 panoramic radiographs of the Clinic LatoSensu IMAGE and 9 of the UDI Odonto clinic were used.

Computed tomography scans of the LatoSensu IMAGE were obtained by two tomographs (OP300 3D and iCat Classic). The field of vision (FOV) was variable since the volumes purchased met the requests of dentists for various evaluations. The operational parameters were also variable. A total of 117 CT scans were used in the sample composition. In the UDI Odonto clinic, 9 CT scans were performed in iCat Classic.

Five x-ray tomographic exams were selected for an examiner calibration and data collection instrument testing. The CBCT was considered in the study as the gold standard, serving as a basis for comparison with the diagnosis of panoramic radiographs. The examiner, a specialist in Dental Radiology, evaluated the images in a room with adequate illumination (low light) in a multiplanar reconstruction workstation (MPR) and 20-inch high-resolution monitor. A data collection form was delivered to the examiner with the appropriate instructions for completing it.

At the end of the examination by the examiner the sample presented a variety of 8 (eight) sinus findings. The sample consisted of 48 (forty-eight) normal maxillary sinuses (18 left, 30 left), 172 (one hundred and seventy-two) mucous thickening (89 right, 83 left), 54 (fifty four) septa (left right), 21 (twenty-one) anthropoids (11 rights, 10 left), 17 (seventeen) mucus retention pseudocysts (12 rights, 5 left), 4 (four) mouth-sinus communications (2 rights; 2 left), 2 (two) maxillary sinuses filled by soft tissue content (right, 2 left), and 12 (twelve) bone grafts (3 right, 9 left).

Panoramic radiographs were analyzed by 3 specialists in Dental Radiology. The images were presented to them in an appropriate room with low light (penumbra). The reproduction of each panoramic radiograph was done by means of a notebook with 14 "screen without the possibility of manipulation of the same ones. The calibration was performed with 5 (five) panoramic images and one model of the datasheet. The evaluators were advised on the possible changes most commonly found in the maxillary sinuses and how to fill the chart.

After evaluating the 126 (one hundred and twenty-six) radiographs, the data collection sheets were collected and the data organized into a spreadsheet in Excel®. A descriptive analysis was performed according to the characteristics of the
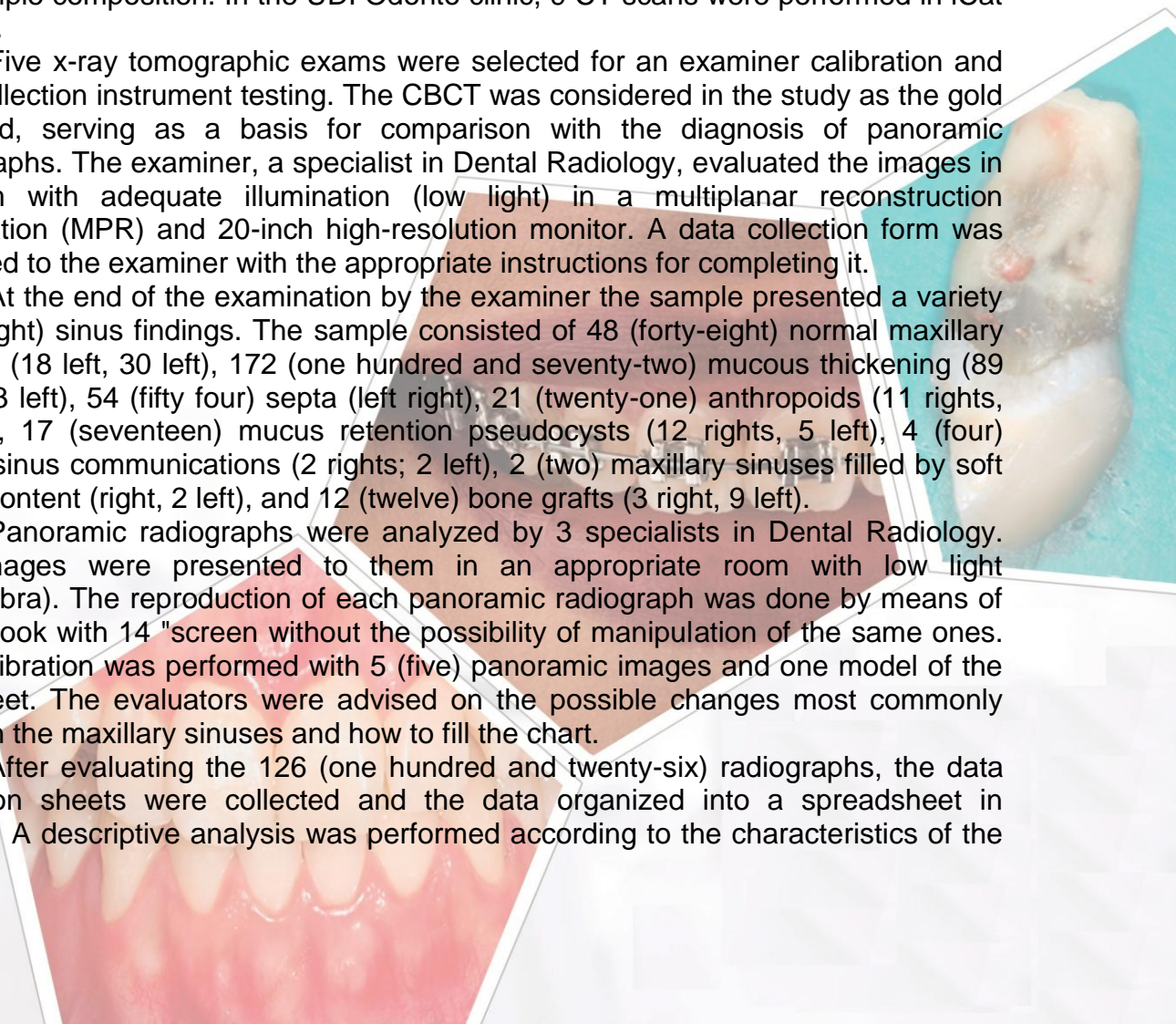
variables. To verify the association of the variables, the q-square test was used, with a confidence test of 95% and significance level of $p < 0.001$.

Results

The sample consisted of 126 patients totaling 378 panoramic radiographic evaluations (126 cases analyzed by 3 evaluators). Panoramic radiography presented a total of 187 (49.46%) correct diagnoses, 97 (24.07%) on the right side and 96 (25.39%) on the left side. The summary can be found in Table 1.

The largest number of correct diagnoses on panoramic radiography was for normal maxillary sinuses (96 / 65.3%). Other findings with the highest number of correct answers were cases in which the sinuses presented bone graft (18/50%) and sinus veins (2 / 33.3%). Septum, anthropoids, mucus retention pseudocysts, sinus communication and mucosal thickening were also diagnosed by the panoramic with the respective percentages of correctness: 29.01%; 3.50%; 22.22%; 8.33%, 22.92% (Table 2).

Table 1: Total correct diagnoses

Exam		Correct Diagnosis	Incorrect Diagnosis	Total
Panoramic Radiography	Right	91 (24,07%)	287 (85,9%)	378
	Left	96 (25,39%)	282 (74,6%)	378

Source: Direct Search
126 reviews by 3 assessors = 378 ratings

Table 2: Total number of correct diagnoses per sinus finding

Find	Panoramic radiography		
	Right		Total
	Direito %	Esquerdo %	
Normal	40 (70,17%)	56 (62,2%)	96 (65,3%)
Mucous Thickening	58 (21,7%)	61 (24,2%)	119 (22,92%)
Septos	20 (28,9%)	27 (29,03%)	47 (29,01%)
Anthracite	1 (3,33%)	1 (3,70%)	2 (3,52%)
Pseudocyst	12 (30,76%)	0 (0,0%)	12 (22,2%)
BS Communication	0 (0,0%)	1 (16,6%)	1 (8,33%)
Graft	7 (77,7%)	11 (40,7%)	18 (50%)
Voucher	0 (0,0%)	2 (33,3%)	2 (33,3%)

Source: Direct Search

Only one of the evaluators reported in some cases that the radiographic image did not present evaluation conditions.

The results of the comparison test showed that the panoramic radiograph did not present adequate diagnostic means for the maxillary sinuses, since there is a statistically significant difference with $p < 0.0001$. When compared to CBCT and findings from evaluator 1, we found quite different data. In addition, for evaluators 2 and 3 we also found significantly different responses when compared to the gold standard. Tables 3, 4 and 6 show a correlation between the findings of the conical beam computed tomography and each evaluator of the panoramic radiographs.

Table 3: Chi-square test between CT and Reviewer 1

		TCFC		Reviewer 1		Value p		TCFC		Reviewer 1		Value p
		Freq	%	Freq	%	Value p		Freq	%	Freq	%	
Right	N	18	14,3	105	83,3		Left	30	23,8	105	83,3	
	EM	89	70,6	2	1,6			83	65,9	4	3,2	
	SEP	23	18,3	13	10,3			31	24,6	12	9,5	
	ANT	11	8,7	0	0,0	p<0,0001		10	7,9	0	0,0	p<0,0001
	OS	12	9,5	6	4,8			5	4,0	2	1,6	
	CBS	2	1,6	0	0,0			2	1,6	0	0,0	
	ENX	3	2,4	1	0,8			9	7,1	2	1,6	
	VEL	0	0,0	1	0,8			2	1,6	1	0,8	

N: Normal; MS: Mucous Thickening; SEP: Septo; ANT: Antacid; PS: Pseudocyst; CBS: Buccosinusal Communication; ENX: Graft; VEL: Velamento.

Table 4: Chi-square test between CT and Reviewer 2

		TCFC		Reviewer 2		Value p		TCFC		Reviewer 2		Value p
		Freq	%	Freq	%	Value p		Freq	%	Freq	%	Value p
	N	18	14,3	51	40,5			30	23,8	46	36,5	
	EM	89	70,6	32	25,4			83	65,9	41	32,5	
	SEP	23	18,3	24	19,0			31	24,6	28	22,2	
	ANT	11	8,7	2	1,6	p<0,0001		10	7,9	2	1,6	p<0,0001
Right	OS	12	9,5	11	8,7		Left	5	4,0	5	4,0	
	CBS	2	1,6	6	4,8			2	1,6	7	5,6	
	ENX	3	2,4	4	3,2			9	7,1	4	3,2	
	VEL	0	0,0	2	1,6			2	1,6	6	4,8	

N: Normal; MS: Mucous Thickening; SEP: Septo; ANT: Antacid; PS: Pseudocyst; CBS: Buccosinusal Communication; ENX: Graft; VEL: Velamento.

Table 5: Chi-square test between CT and Reviewer 3

		TCFC		Reviewer 3		Value p		TCFC		Reviewer 3		Value p
		Freq	%	Freq	%	Value p		Freq	%	Freq	%	
	N	18	14,3	62	49,2			30	23,8	71	56,3	
	EM	89	70,6	36	28,6			83	65,9	40	31,7	
	SEP	23	18,3	23	18,3			31	24,6	13	10,3	
	ANT	11	8,7	0	0,0	p<0,0001		10	7,9	0	0,0	p<0,0001
Right	PS	12	9,5	8	6,3		Left	5	4,0	3	2,4	
	CBS	2	1,6	1	0,8			2	1,6	0	0,0	
	ENX	3	2,4	4	3,2			9	7,1	5	4,0	

VEL	0	0,0	2	1,6		2	1,6	2	1,6

N: Normal; MS: Mucous Thickening; SEP: Septo; ANT: Antacid; PS: Pseudocyst; CBS: Buccosinusal Comunication; ENX: Graft; VEL: Velamento.

Discussion

Knowledge about the anatomical and pathological relationship between posterior teeth of the maxilla or edentulous areas and the maxillary sinus is crucial for the diagnosis and treatment planning. Panoramic radiography routinely used as an imaging diagnostic instrument in dentistry is a very affordable method, with low cost and low dose of radiation. However, the panoramic images have innumerable limitations inherent in the technique, since it is a two-dimensional and dynamic examination, which is very sensitive to positional errors, making it impossible to evaluate the regions of the maxilla in close proximity to the maxillary sinuses.[7-8].

This fact is in agreement with the present study since this presented significant statistical differences between the findings in panoramic radiographs and CBCT (gold standard).

In the analysis of the variety of sinus findings found, there was no difference between the findings of CBCT and panoramic radiographs, a fact also reported by Altzinger et al.[9] in his study. There was only one report that some panoramic images did not have conditions of visualization.

An accurate evaluation of the maxillary sinuses is fundamental for the planning of some treatments due to the proximity relationship between the alveolar process of the maxilla and the maxillary sinuses. For some authors, implant procedures in the maxilla region are widely performed and often planned with a panoramic radiograph. It is frequently stated that evaluation of the maxillary sinuses is possible with panoramic radiographs and CBCT, but the precise evaluation of the maxillary nodes is not adequate by panoramic radiographs.[10-11]

In Implantology, clinicians commonly use 2D and 3D exams, but both involve advantages and disadvantages. The CBCT is used to detail mainly anatomy and bone quality, as well as pathologies. It is often considered the highest amount of radiation and the highest price of the exam. According to Altzinger et al.[19], the panoramic radiograph provides a sufficient view of the maxillary sinuses for basic diagnoses, and may be a suitable method for initial diagnosis. However, an accurate evaluation of the maxillary sinuses requires the solicitation of three-dimensional exams.[12-13]

Altzinger et al.[9] when analyzing different anatomical variations and pathologies of the maxillary sinus found in panoramic radiography, comparing them to those initially detected in CBCT images, concluded that there is a moderate risk for the false diagnosis of maxillary sinus findings if it is panoramic radiography only. According to the results of this study, the risk of false diagnosis is quite significant, a fact proven with the statistical data found, evidencing the low percentage of correct diagnoses using panoramic radiography.

In another study, Maestre et al.[14] compared the efficacy of panoramic radiography, computed tomography and CBCT in the diagnosis of sinus mucosal thickening, mucosal cysts or full opacity, and showed that the panoramic radiograph was comparatively inferior to the other methods. We also found in this study that the accuracy of panoramic radiographic findings for mucosal thickening and mucus retention cysts was much lower.
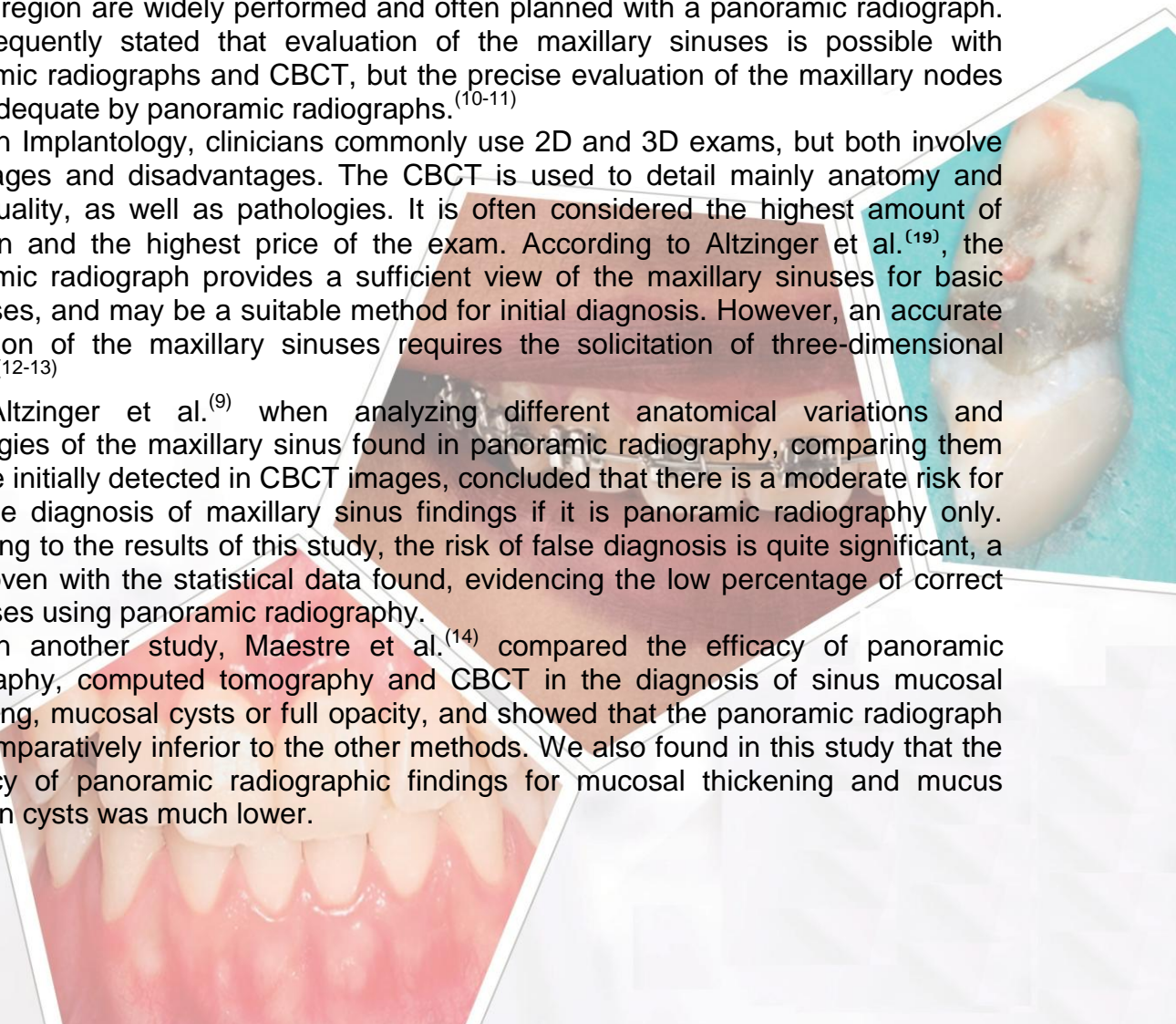
Thickening of the maxillary sinus mucosa is the most common affection in the region of the maxillary sinuses. Thickening indicates some type of irritation and may be related to the proximity of the roots of the posterior teeth to the floor of the sinus cavity. The intima relationship between the roots of the maxillary first molars and the maxillary sinus acts as one of the factors that cause this alteration, which can be visualized by both panoramic radiographs and TCFC.[15-16]

It was noted after tabulation of the results that mucosal thickening in the maxillary sinuses was the most frequent finding. It was not the objective of this study to relate findings with variables such as age, however it is worth mentioning that the prevalence of this alteration may be related to the age group. Older patients may have some degree of mucosal thickening more frequently due to injuries sustained for years, such as tooth loss, alveolar extensions, periodontal diseases, among others.[17-18]

Although we found mucosal thickening in approximately 68% of the maxillary sinuses evaluated by the TCFC, a very small percentage (22.92%) (Table 2) was found when viewing the panoramic radiograph. In the study conducted by Pacenko et al., They concluded that there is a concordance between the findings of panoramic radiography and CBCT for this pathology, but the authors emphasized that if thickening smaller than 3mm were analyzed, they would not be visualized in panoramic radiography. It is worth mentioning that some factors could lead to this difference in results, since in our study there was no reproducibility test for the evaluation of panoramic radiographs and, in addition, two different devices were used in the acquisition of the images.[6]

Regarding the presence of septa, several reports in the literature show that panoramic radiography may not be effective in this diagnosis. In this study panoramic radiography detected about 29% of the total septa present. For Maestre et al.[14] panoramic radiography showed almost half of the cases of septa, leading to false-positive and false-negative findings. Also according to Krennmair et al.[19] the same imprecision of panoramic radiography in the detection of maxillary sinus septa in 13 of 61 cases was observed. In the study by Altzinger et al.[9] there was no significant difference between the 2D and 3D imaging methods in the detection of septa. Therefore, a complete study of the maxillary sinus should be performed using three-dimensional examination when this region needs to be evaluated.

Panoramic radiography provides information about the maxillary sinuses, and can be used as a diagnostic imaging method. However, particular findings in panoramic images may vary according to the examiner. The inter- and intra-examiner variation in the interpretation of panoramic radiographs characterizes the method as evaluator-dependent. Therefore, an adequate and reliable evaluation of the maxillary sinuses is only possible using CBCT.[9,20]

Conclusion

Panoramic radiography is one of the most widely used diagnostic imaging methods in dentistry. In this study, it was possible to find in the panoramic view the same variety of findings and sinus pathologies as in CBCT, but the number of correct answers in the general examination was quite different. The greatest number of hits was for normal maxillary sinuses. Panoramic radiography was significantly lower in mucosal thickening, mucus retention cyst, anthrocytes and oral-sinusal communication. Thus, even in the face of easy access, low cost and ease of execution, panoramic radiography is not accurate in the analysis of the pathologies and findings in the maxillary sinuses when compared to concomitant computed tomography.
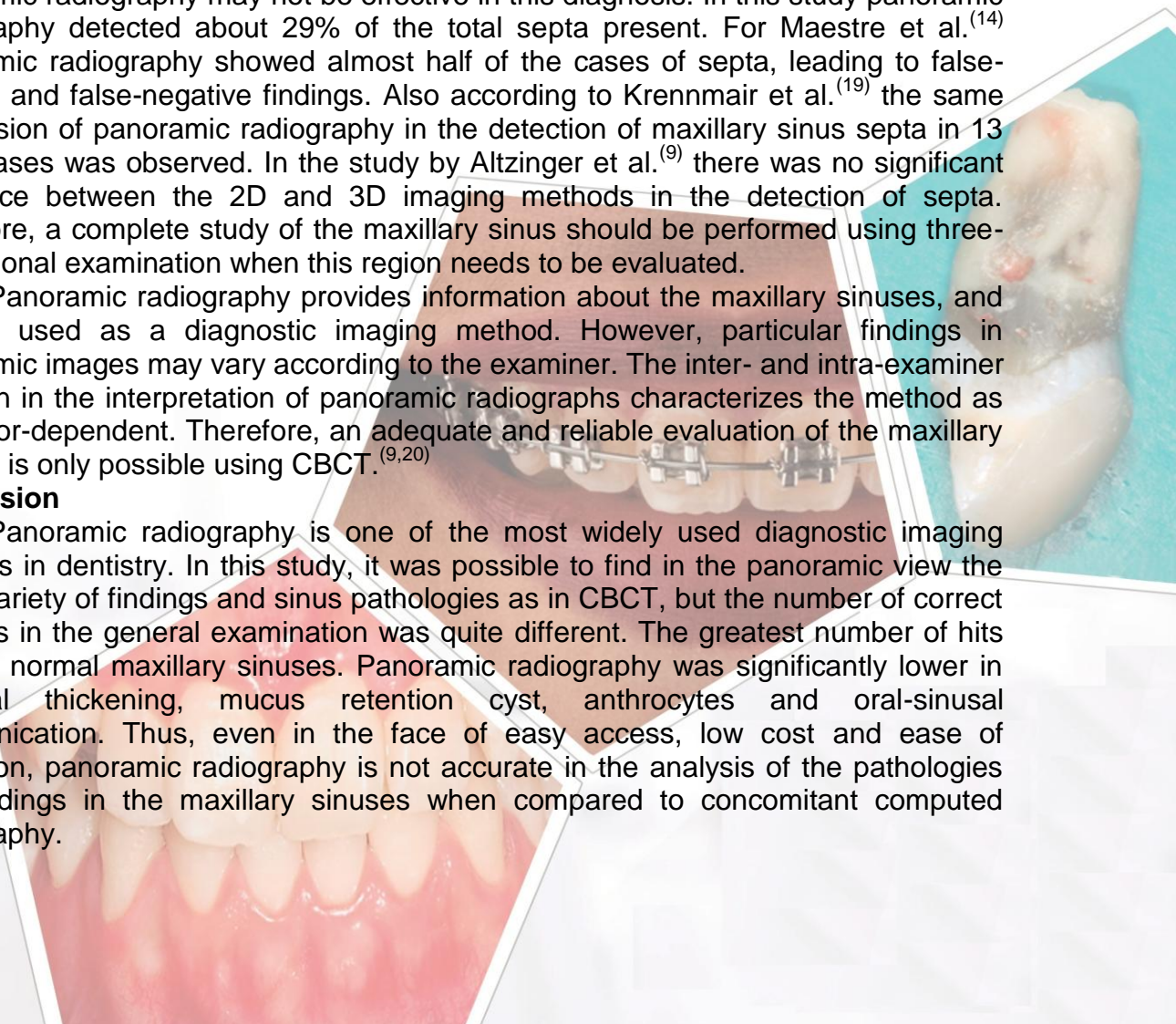
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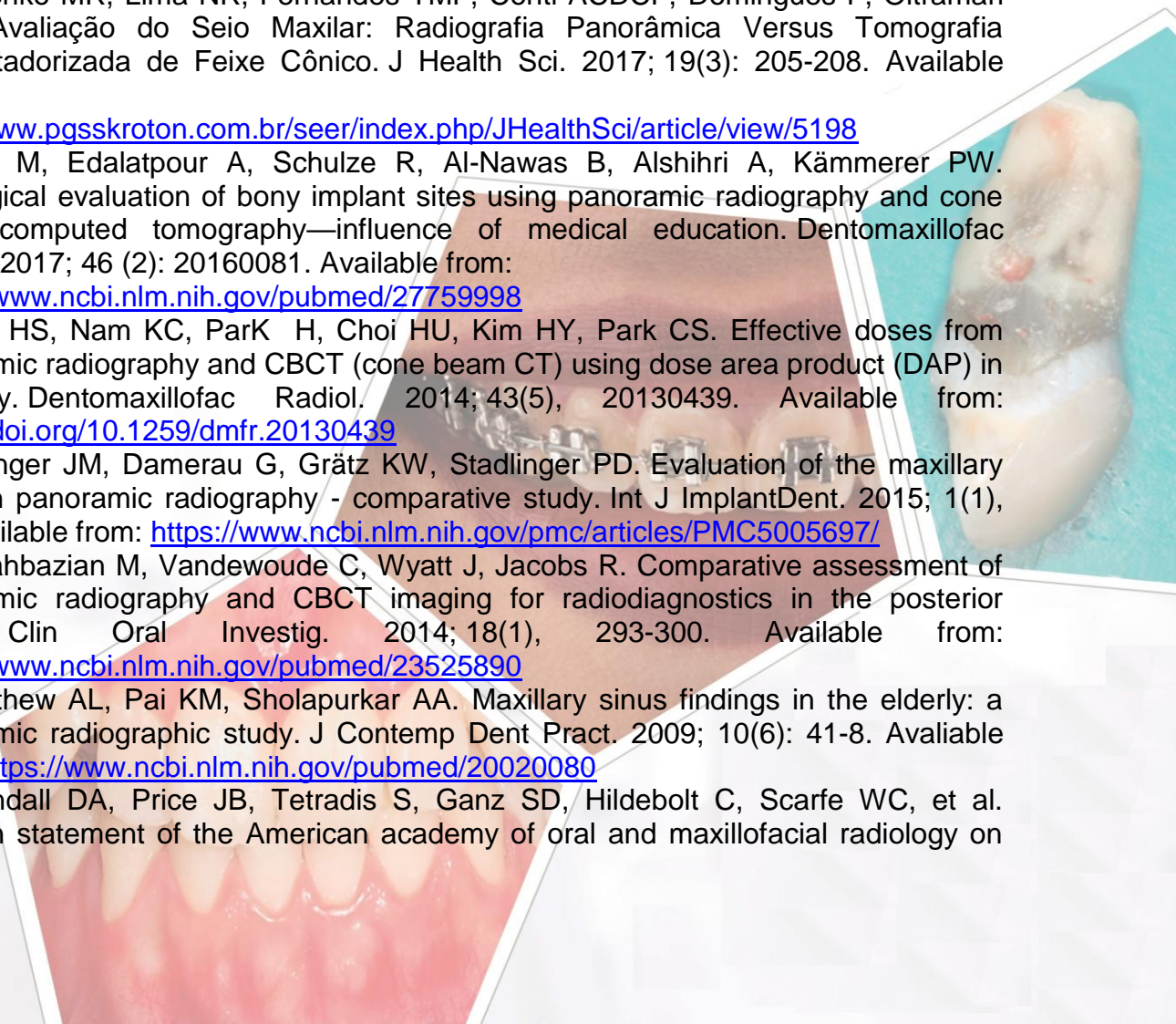
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