Is panoramic radiography reliable to evaluate the relationship between maxillary molar and premolar roots and the maxillary sinus?

A radiografia panorâmica é confiável para avaliar a relação entre as raízes dos molares e pré-molares superiores e o seio maxilar?

¿Es confiable la radiografía panorámica para evaluar la relación entre las raíces de los molares y premolares maxilares y el seno maxilar?

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Abstract
Aim: To evaluate the radiographic signs of proximity relationship between maxillary molar roots and maxillary sinus in panoramic radiographs, using CBCT as control. Methods: 81 examinations of patients who had panoramic radiographs and CBCT of the maxillary molars and pre molars region were used. Pathological situations were excluded from this study. Panoramic radiographs and CBCT were evaluated randomly and separately by an experienced dental radiology examiner. 1,055 root apices were evaluated individually. When assessing the relationship between maxillary molar and pre molar apices, and maxillary sinus, the examiner rated the images, both in panoramic radiography and CBCT, according to a scale of 0 to 3, where 0–Without relationship or distant; 1-Root apex projection or overlapping; 2-Maxillary sinus circumventing the tooth root; 3-Interruption of the continuity of maxillary sinus floor. Tabulated data were statistically analyzed using Kappa test and interclass correlation coefficient (ICC) respectively, with a significance level of 5%. A second analysis of the sample was performed after 15 days to analyze reproducibility. Results: Kappa test indicated near perfect reproducibility (Kw=0.973). The highest prevalence ratio, when comparing the classification in panoramic radiographs and CBCT, was for type 1 (52,7%). There was no difference between the type 1 signal and the gold standard observed on CBCT (ρ=0.2152). Conclusion: Panoramic radiography can be used to evaluate the relationship between roots of maxillary molars and premolars with the maxillary sinus. For cases where there is overlapping between apices and maxillary sinus, CBCT remains the indicated exam for better evaluation.
Keywords: Panoramic radiograph; Computerized tomography; Maxillary sinus; Oral radiology.

Resumo

Objetivo: Avaliar os sinais radiográficos da relação de proximidade entre as raízes dos molares superiores e o seio maxilar em radiografias panorâmicas, utilizando a CBCT como controle. Métodos: Foram utilizados 81 exames de pacientes que tiveram radiografias panorâmicas e CBCT da região de molares e pré-molares superiores. Situações patológicas foram excluídas deste estudo. Radiografias panorâmicas e CBCT foram avaliadas aleatoriamente e separadamente por um examinador experiente em radiologia odontológica. 1.055 ápices radiculares foram avaliados individualmente. Ao avaliar a relação entre os ápices dos molares e pré-molares superiores e o seio maxilar, o examinador classificava as imagens, tanto na radiografia panorâmica quanto na TCFC, segundo uma escala de 0 a 3, onde 0 – Sem relação ou distante; 1- Projeção ou sobreposição do ápice radicular; 2- Seio maxilar contornando a raiz do dente; 3-Interrupção da continuidade do assoalho do seio maxilar. Os dados tabulados foram analisados estatisticamente por meio do teste Kappa e coeficiente de correlação interclasse (ICC), respectivamente, com nível de significância de 5%. Uma segunda análise da amostra foi realizada após 15 dias para analisar a reprodutibilidade. Resultados: O teste Kappa indicou reprodutibilidade quase perfeita (Kw=0,973). A maior razão de prevalência, quando comparada a classificação em radiografias panorâmicas e TCFC, foi para o tipo 1 (52,7%). Não houve diferença entre o sinal tipo 1 e o padrão-ouro observado na CBCT (ρ=0,2152). Conclusão: A radiografia panorâmica pode ser utilizada para avaliar a relação das raízes dos molares e pré-molares superiores com o seio maxilar. Para os casos em que há sobreposição entre os ápices e o seio maxilar, a CBCT continua sendo o exame indicado para melhor avaliação.

Palavras-chave: Radiografia panorâmica; Tomografia computadorizada; Seio maxilar; Radiologia oral.

Resumen

Objetivo: Evaluar los signos radiográficos de la relación de proximidad entre las raíces de los molares maxilares y el seno maxilar en radiografías panorámicas, usando CBCT como control. Métodos: Se utilizaron 81 exámenes de pacientes a los que se les realizaron radiografías panorámicas y CBCT de la región de molares y premolares maxilares. Las situaciones patológicas fueron excluidas de este estudio. Las radiografías panorámicas y CBCT fueron evaluadas al azar y por separado por un examinador de radiología dental experimentado. Se evaluaron individualmente 1.055 ápices radiculares. Al evaluar la relación entre los ápices de los molares y premolares maxilares y el seno maxilar, el examinador califica las imágenes, tanto en radiografía panorámica como en CBCT, según una escala de 0 a 3, donde 0– Sin relación o distante; Proyección o superposición del ápice de 1 raíz; 2-Seno maxilar circunvalando la raíz del diente; 3-Interrupción de la continuidad del suelo del seno maxilar. Los datos tabulados se analizaron estadísticamente mediante la prueba de Kappa y el coeficiente de correlación interclase (CCI) respectivamente, con un nivel de significancia del 5%. A los 15 días se realizó un segundo análisis de la muestra para analizar la reproducibilidad. Resultados: la prueba de Kappa indicó una reproducibilidad casi perfecta (Kw=0,973). La razón de prevalencia más alta, al comparar la clasificación en radiografías panorámicas y CBCT, fue para el tipo 1 (52,7%). No hubo diferencia entre la señal de tipo 1 y el patrón oro observado en CBCT (ρ=0,2152). Conclusión: La radiografía panorámica se puede utilizar para evaluar la relación entre las raíces de los molares y premolares maxilares con el seno maxilar. Para los casos en que exista superposición entre ápices y seno maxilar, el CBCT sigue siendo el examen indicado para una mejor evaluación.

Palabras clave: Radiografía panorámica; Tomografía computarizada; Seno maxilar; Radiología bucal.

1. Introduction

The maxillary sinus is a wide cavity located in the body and zygomatic bone of the maxilla. Its development occurs until all permanent teeth erupt; its anteroposterior growth is associated with the development of the maxillary tuberosity (Teixeira et al., 2001; Da Silva et al., 2017). Its extension is variable in adults, and its floor may extend between adjacent teeth or roots (Neelakantan et al., 2010; Tank, 2010).

Knowledge of the topography between the apical portion of the teeth and the floor of the maxillary sinus is important for diagnosis, planning and prognosis of dental implants, endodontics, orthodontics, and surgical procedures (Kwak et al., 2004). If a close relationship between these structures is established, procedures may lead to oral-antral communication, sinusitis due to the dissemination of a periapical or periodontal odontogenic infection or due to an iatrogenic perforation and even the displacement of the tooth into the maxillary sinus (Watzek & Bernhart, 1997; Hauman et al., 2002; Ergstrom et al., 1988; Durmus, et al., 2004).

Panoramic radiography is used to evaluate dental structures in general (Chilvarquer et al., 2008). It has the advantage of visualizing the entire maxillomandibular complex, temporomandibular joint, and, also allows the evaluation of surrounding structures, such as the maxillary sinuses, using a minimum dose of radiation for that purpose (Van & Milles, 1994). However, the technique presents superimposition of structures, formation of phantom images, magnifications, and distortions (Bouquet et

al., 2004; Langland, 1968). Despite this, panoramic radiography is the exam of choice for professionals who want to make a general assessment of the patient, and often for evaluation and planning of surgeries associated with third molars (Sharan, 2006; Takeshita et al., 2014; Takeshita et al., 2015).

When the panoramic radiograph is not sufficient for a clear diagnosis, other modalities of examination may be requested, among them, Cone-Beam Computed Tomography (CBCT). For a more precise evaluation of the anatomical structures adjacent to the alveolar process, such as the mandibular canal, nasal cavity and maxillary sinus, this examination modality is strongly recommended (Tyndall, 2000). CBCT consists of several continuous sections that can be viewed in three different planes: axial, coronal and sagittal, eliminating image overlapping and allowing a better evaluation of the extent of the maxillary sinus (Takeshita et al., 2015; Tyndall, 2000; Frederiksen, 2007; Fernandes et al., 1987).

Previous studies have compared the relationship of proximity between maxillary molar roots and the floor of the maxillary sinus using panoramic radiographs and CBCT. The results show great variability in the topographic relationships between the exams regarding these structures (Lopes et al., 2016; Roque-Torres et al., 2015). Therefore, the aim of this study was to evaluate the radiographic signs of proximity relationship between maxillary molar roots and maxillary sinus in panoramic radiographs, using CBCT as control.

2. Materials and Methods

The present study was submitted and approved by the Independent Ethics Committee (IRB/IEC) for research on human beings of the University Hospital of the Federal University of Sergipe, under opinion 2,050,804. The sample was selected based on the image files of the institution's Oral Diagnosis department. A total of 81 examinations of patients who had panoramic radiographs and CBCT of the maxillary molars and pre molars region were used.

The sample included examinations of patients of both genders, aged between 18 and 60 years, without distinction of race, social class or socioeconomic status, and with at least one upper and posterior tooth. All images had a satisfactory standard level of sharpness, density and contrast, where it was possible to clearly observe the dental apices and the maxillary sinus. Pathological situations such as cysts, tumors, root resorption, chronic periapical lesion and bone pathologies were excluded from this study.

Panoramic radiographs and CBCT scans were evaluated randomly and separately by a dental radiology examiner under appropriate light conditions. A total of 1,055 root apices were evaluated individually. The panoramic radiographic images were evaluated using the Windows 10 photo viewer, where the examiner could use tools, such as zoom and adjust brightness and contrast for their evaluation.

When assessing the relationship between maxillary molar and pre molar apices, and maxillary sinus, the examiner rated the images according to a scale of 0 to 3, where 0 – Without relationship or distant; 1- Root apex projection or overlapping; 2- Maxillary sinus circumventing the tooth root; 3- Interruption of the continuity of maxillary sinus floor. Figure 1-A exemplifies the classification used on the images in the panoramic radiographs. The data were then recorded in a table in Microsoft Excel Office 2019.

Figure 1 – A: Panoramic radiograph clippings and their proper classification. The number in the upper right corner of the image indicates its rating, where 0 means without relationship or distant; 1 means root apex projection or overlapping; 2 means maxillary sinus circumventing the tooth root; and 3 means interruption of the continuity of maxillary sinus floor. B: CBCT reconstructions and their proper classification.
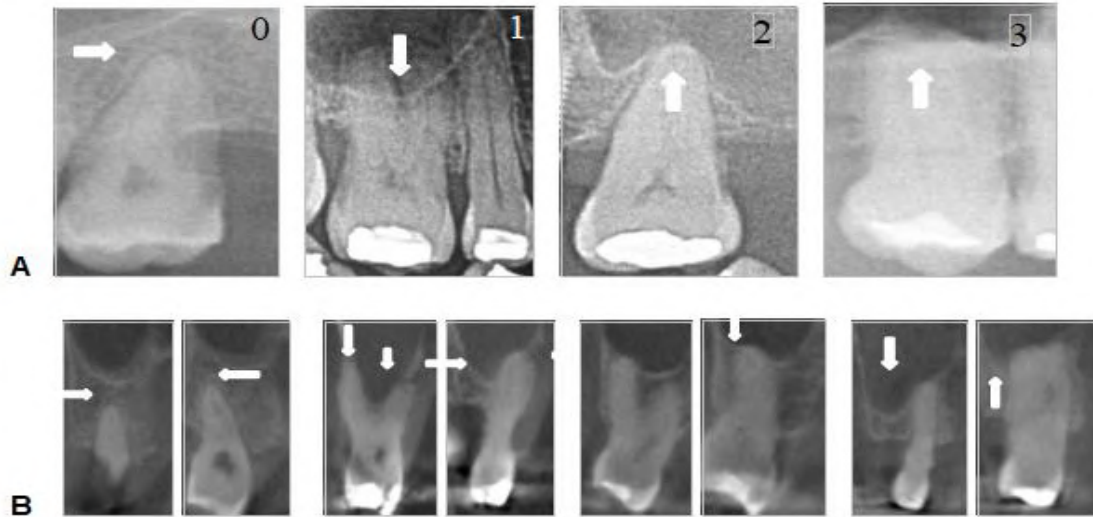
Source: Authors.

The CBCT images formed the control group. The analysis of these images was performed in CS 3D Imaging software by an experienced radiologist under the same lighting conditions and with access to tools to change zoom, brightness and contrast. The examiner had access to the entire DICON for each case and did the analysis and classification after evaluating the axial, coronal and sagittal reconstructions. The same classification used in the evaluation of images in panoramic radiographs was used for the evaluation of CBCT images. Figure 1-B exemplifies the classification used in the CBCT images. The data were recorded in a table in Microsoft Excel Office 2019.

The tabulated data were then statistically analyzed using Kappa test and interclass correlation coefficient (ICC) respectively, with a significance level of 5%, using the statistical software SAS® (Statistical Analysis Software Institute Inc. Cary, NC, USA) and SPSS® version 22.0 (IBM Corporation, Armonk, NY; formerly SPSS Inc., Chicago, IL). A second analysis with approximately 20% of the sample was performed after 15 days to analyze reproducibility.

3. Results

Within the proposed methodology, the results obtained from the Kappa test indicated near perfect reproducibility (Landis, et al. 1977), Kw = 0.973 (Table 1).

Table 1 – Interpretation of Kappa values (Kw).

Kappa values	Interpretation
<0	No agreement
0-0.19	Poor agreement
0.20-0.39	Fair agreement
0.40-0.59	Moderate agreement
0.60-0.79	Substantial agreement
0.80-1.00	Almost perfect agreement

Source: Landis JR, Koch GG. *The measurement of observer agreement for categorical data.* Biometrics 1977; **33**: 159-174. [29]

The highest prevalence ratio, when comparing the classification in panoramic radiographs and CBCT, was for type 1, where root overlap with the maxillary sinus floor was observed in 52.7% of cases (Table 2)

Table 2 – Distribution of the types of signals of intimate relationship in panoramic radiography as compared with the gold standard, the TCFC.

Type	Evaluation at PAN	CBCT (gold standard) Without relationship	Intimate relationship	CCI	IC$_{95\%}$	*P* value
0	462	462	0	1.000		
1	556	189	367	0.053	-0.03 a 0.14	0.2152
2	26	0	26	1.000		
3	11	0	11	1.000		
Total	1055 (100%)	651	404			

*ρ<0.05 (statistically significant difference). Source: Authors.

Furthermore, applying the interclass correlation coefficient (ICC), there was no difference between the type 1 signal and the gold standard observed on CBCT with ρ=0.2152, accepting the null hypothesis. The classifications into type 0, 2 and 3 showed equality when compared to the control group (Table 3).

Table 3 – Distribution of the different types of signals of intimate relationship in panoramic radiography, when comparing gold standard to CBCT.

Teeth/root	Type	Evaluation at PAN N (%)	Without relationship	Intimate relationship	CCI	IC$_{95\%}$	*P* value
1° Premolar RP	0	83 (83%)	83	0	1.000		
	1	17 (17%)	13	4	0.451	-0.04 a 0.77	0.0653
1° Premolar RV	0	78 (78%)	0	78	1.000		
	1	22 (22%)	15	7	0.146	-0.16 a 0.42	0.3452
2° Premolar RP	0	38 (44,7%)	38	0	1.000		
	1	44 (51,8%)	14	30	0.104	-0.20 a 0.39	0.5009
	3	3 (3,5%)	0	3	1.000		
2° Premolar RV	0	40 (48,2%)	40	0	1.000		
	1	43 (51,8%)	23	20	0.144	-0.16 a 0.43	0.3572
1st Molar MV	0	28 (36,9%)	28	0	1.000		
	1	44 (57,9%)	18	26	0.127	-0.18 a 0.41	0.4117

	2	2 (2,6%)	0	2	1.000	
	3	2 (2,6%)	0	2	1.000	
1st Molar DV	0	30 (38,4%)	30	0	1.000	
	1	46 (59%)	21	25	0.143	-0.15 a 0.42	0.344
	2	2 (2,6%)	0	2	1.000	
1st Molar P	0	24 (30,5%)	24	0	1.000	
	1	51 (64,5%)	6	45	0.052	-0.23 a 0.32	0.7189
	2	4 (5%)	0	4	1.000	
2nd Molar MV	0	28 (26,2%)	28	0	1.000	
	1	68 (63,5%)	16	52	0.068	-0.17 a 0.30	0.5829
	2	9 (8,4%)	0	9	1.000	
	3	2 (1,9%)	0	2	1.000	
2nd Molar DV	0	45 (42,9%)	45	0	1.000	
	1	57 (54,3%)	22	45	0.106	-0.16 a 0.36	0.4328
	2	2 (1,9%)	0	2	1.000	
	3	1 (0,9%)	0	1	1.000	
2nd Molar P	0	18 (17%)	18	0	1.000	
	1	80 (75,5%)	17	63	0.058	-0.16 a 0.27	0.6066
	2	7 (6,6%)	0	7	1.000	
	3	1 (0,9%)	0	1	1.000	
3rd Molar MV	0	14 (36,9%)	14	0	1.000	
	1	23 (60,5%)	6	17	0.127	-0.30 a 0.51	0.5647
	3	1 (2,6%)	0	1	1.000	
3rd Molar DV	0	15 (40,5%)	15	0	1.000	
	1	22 (59,5%)	7	15	0.165	-0.28 a 0.55	0.4632
3rd Molar P	0	12 (32,4%)	12	0	1.000	
	1	24 (64,9%)	3	21	0.079	-0.34 a 0.47	0.7143
	3	1 (2,7%)	0	1	1.000	

*$p<0.05$ (statistically significant difference). Source: Authors.

4. Discussion

This study aimed to evaluate the radiographic signs of proximity relationship between maxillary molar roots and maxillary sinus in panoramic radiographs, using CBCT as control. Panoramic radiography provides a general view of the facial anatomy, including the maxillary sinus and the dental roots, with a lower radiation dose when compared to the exposure dose using CBCT; however, some cases require CBCT for a clearer and more precise evaluation of the relationship between the floor of the maxillary sinus and the dental apices when there is doubt in the diagnosis of this relationship, or in case of evidence of root protrusion in the sinus (Rodrigues et al., 2013; Kilic et al., 2010).

Due to the limitations of the panoramic radiography acquisition technique, an accurate determination of the relationship between molar and pre-molar roots and the floor of the maxillary sinus is not always possible. Frequently, the roots of these teeth are projected into the maxillary sinus, and often distorted (Kilic et al., 2010; Yoshimine et al., 2012). Some studies have attempted to quantify this distortion using CBCT as a control, but the values found show great variability.

The possibility of analyzing the image in three dimensions makes CBCT the ideal exam to evaluate the true relationship between the maxillary sinus and the dental apexes (Shakhawan; Falah; Kawa, 2012). This allows an accurate and undistorted evaluation, ideal for diagnosis and clinical planning. However, its high cost and the dose to which the patient is submitted make

this exam only be requested in case of doubts generated in the evaluation of the panoramic radiograph (Roque-Torres et al., 2015; Rodrigues et al., 2013; Kilic et al., 2010; Yoshimine et al., 2012).

In this study, the roots were evaluated individually, which methodologically diverges from the studies found in the literature (Rodrigues et al., 2013). For all conditions analyzed there was no intimate relationship between the structures in 43.8% of the roots evaluated. Moreover, the projection of the root apex under the floor of the maxillary sinus was found in 52.7% of the roots evaluated.

It was also observed a high rate of intimate relationship between the floor of the maxillary sinus and the dental root, which, when compared with other studies, was relatively low, which could be explained by the use, as control group, of helical computed tomography, which provides less detailing of dental structures and the floor of the maxillary sinus 26 and 27.

As for root differentiation, the palatal root of the second molar was the most related to the maxillary sinus, diverging from other studies which indicate that the mesio-vestibular root 33 and the distal vestibular root 32, has the highest incidence.

Furthermore, the results found showed that the panoramic radiograph provided reliable information when there was no relationship between these anatomical structures, as well as for signs of discontinuity of the sinus floor, or when the sinus floor went around the tooth root, forming a kind of dome. Such data are in agreement with other similar studies that confirm the high correlation between panoramic radiograph and CBCT when the roots are not in contact with the floor of the maxillary sinus (Jung; Cho, 2012; Landis; Koch, 1977).

5. Conclusion

Within the limitations presented, panoramic radiography can be used to evaluate the relationship between roots of maxillary molars and premolars with the maxillary sinus, not ruling out the diagnostic precision that CBCT promotes. For cases where there is overlapping between apices and maxillary sinus, CBCT remains the indicated exam for better evaluation.

References

Bouquet, A., Coudert, J. L., Bourgeois, D., Mazoyer, J. F., & Bossard, D. (2004) Contributions of reformatted computed tomography and panoramic radiography in the localization of third molars relative to the maxillary sinus. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 98:342-7.

Chilvarquer, I., Hayek, J. E., & Chilvarquer, L. W0. Planejamento virtual. In: Carvalho PSP. (2008) A excelência do planejamento em implantodontia. São Paulo: Santos, 53-708.

Da Silva, A. F., Fróes, G. R. Jr, Takeshita, W. M., Da Fonte, J. B., De Melo, M. F., & Sousa Melo, S. L. (2017) Prevalence of pathologic findings in the floor of the maxillary sinuses on cone beam computed tomography images. *Gen Dent.* 65(2):28-32.

Durmus, E., Dolanmaz, D., Kucukkolbsi, H., & Mutlu, N. (2004) Accidental displacement of impacted maxillary and mandibular third molars. *Quintessence Int* 35:375-7.

Engström, H., Chamberlain, D., Kiger, R., & Egelberg, J. (1988) Radiographic evaluation of the effect of initial periodontal therapy on thickness of the maxillary sinus mucosa. *Journal of periodontology*. 59(9):604-608.

Fernandes, R., Azarbal, M., Ismail, Y., & Curtin, H. (1987) A cephalometric tomographic technique to visualize the buccolingual and vertical dimensions of the mandible. *The Journal of Prosthetic Dentistry*. 58(4):466-470.

Frederiksen, N. L. (2007) Técnicas especiais de imagem. In: White SC, Pharoah M J. *Radiologia Oral: fundamentos e interpretação*. Rio de Janeiro: Elsevier, p. 247-64.

Hauman, C., Chandler, N., & Tong, D. (2002) Endodontic implications of the maxillary sinus: a review. *International Endodontic Journal*. 35(2):127-141.

Jung, Y., & Cho, B. (2012) Assessment of the relationship between the maxillary molars and adjacent structures using cone beam computed tomography. *Imaging Science in Dentistry*. 42(4):219.

Kilic, C., Kamburoglu, K., Yuksel, S. P., & Ozen, T. (2010) An assessment of the relationship between the maxillary sinus floor and the maxillary posterior teeth root tips using dental cone-beam computerized tomography. *Eur J Dent* 4: 462–7.

Kwak, H., Park, H., Yoon, H., Kang, M., Koh, K., & Kim, H. (2004) Topographic anatomy of the inferior wall of the maxillary sinus in Koreans. *International Journal of Oral and Maxillofacial Surgery*. 33(4):382-388.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *biometrics*, 159-174.

Langland, O., & Sippy, F. (1968) Anatomic structures as visualized on the orthopantomogram. *Oral Surgery, Oral Medicine, Oral Pathology.* 26(4):475-484.

Lopes, L., Gamba, T., Bertinato, J., & Freitas, D. (2016) Comparison of panoramic radiography and CBCT to identify maxillary posterior roots invading the maxillary sinus. *Dentomaxillofacial Radiology.* 45(6):20160043.

Neelakantan, P., Subbarao, C., Ahuja, R., Subbarao, C., & Gutmann, J. (2010) Cone-beam computed tomography study of root and canal morphology of maxillary first and second molars in an indian population. *Journal of Endodontics.* 36(10):1622-1627.

Rodrigues, G. H. C., Rodrigues, V. A., Barros, S. M., Ximenez, M. E. L., & Souza, D. M. (2013) Correlação entre as medidas lineares em radiografias panorâmicas e tomografias computadorizadas cone beam associadas ao seio maxilar. *Pesqbrasodontopedclin integr.* 13(3):245-49

Roque-Torres, G., Ramirez-Sotelo, L., Almeida, S., Ambrosano, G., & Bóscolo, F. (2015) 2D and 3D imaging of the relationship between maxillary sinus and posterior teeth. *Brazilian Journal of Oral Sciences.* 14(2):141-148.

Shakhawan, M., Falah, A., & Kawa, A. (2012) The relation of maxillary posterior teeth roots to the maxillary sinus floor using panoramic and computed tomography imaging in a sample of kurdish people. *Tikrit Journal for Dental Sciences.* 81-88.

Sharan, A., & Madjar, D. (2006) Correlation between maxillary sinus floor topography and related root position of posterior teeth using panoramic and cross-sectional computed tomography imaging. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 102(3):375-381.

Takeshita, W. M., Vessoni Iwaki, L. C., Da Silva, M. C., & Tonin, R. H. (2014) Evaluation of diagnostic accuracy of conventional and digital periapical radiography, panoramic radiography, and cone-beam computed tomography in the assessment of alveolar bone loss. *Contemp Clin Dent.* 5(3):318-23. 10.4103/0976-237X.137930.

Takeshita, W. M., Chicarelli, M., & Iwaki, L. C. (2015) Comparison of diagnostic accuracy of root perforation, external resorption and fractures using cone-beam computed tomography, panoramic radiography and conventional & digital periapical radiography. *Indian J Dent Res.* 26(6):619-26. 10.4103/0970-9290.176927.

Tank, P. W. (2005) Grant's Dissector. (13a ed.), Lippincott Williams & Wilkins, 198.

Teixeira, L., Reher, P., & Reher, V. (2001) *Anatomia aplicada à odontologia*. Guanabara Koogan.

Tyndall, D. A., & Brooks, S. L. (2000) Selection criteria for dental implant site imaging: a position paper of the American Academy of Oral and Maxillofacial radiology. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 89:630-7.

Van Dis, M. L., & Milles, D. A. (1994) Disorder of the maxillary sinus. *Dent Clin North Am. Philadelphia,* 38(1), 155-166.

Watzek, G., Bernhart, T., & Ulm, C. (1997) Complications of sinus perforations and their management in endodontics. *Dent Clin North Am* 41:563-83.

Yoshimine, S., Nishihara, K., Nozoe, E., Yoshimine, M., & Nakamura, N. (2012) Topographic analysis of maxillary premolars and molars and maxillarysinus using cone beam computed tomography. *Implant Dent*. 21:528-35.