

PREDICTIVE VALIDITY OF THE DENTAL RADIOGRAPHY FOR OROANTRAL PERFORATION DURING TOOTH EXTRACTION

VALOR PREDITIVO DA RADIOGRAFIA ODONTOLÓGICA PARA COMUNICAÇÃO BUCOSINUSAL DURANTE EXODONTIAS

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ABSTRACT

Background: In Oral Surgery, conventional dental radiography (DXR) is widely used to evaluate the tooth root and the adjacent structures. During dental extraction, if the tooth root is too close to the maxillary sinus it may be displaced into the maxillary sinus or an oroantral perforation (OAP) may be possibly established. This study aimed to determine the validity of DXR screening in detecting radiological findings compatible with the close relationship between the tooth root, the maxillary sinus and the prevalence of OAP in dental extraction.

Methods: This study examined all medical records of individuals treated at Dental School of Ponta Grossa State University – Brazil, in 2016 and 2017. The inclusion criteria were: medical records with DXR; medical records with upper posterior tooth extraction. The exclusion criteria were medical records without DXR; medical records with mandibular tooth extraction; medical records with upper anterior tooth extraction; medical records without tooth extraction. The close relationship between the tooth root and the maxillary sinus were evaluated in DXR of upper posterior teeth extracted and the occurrence of OAP was clinically verified. The predictive validity of DXR for OAP was measured. The values of sensitivity, specificity, positive predictive value and negative predictive value, likelihood ratio and odds ratio were calculated.

Results: The prevalence of OAF = 0,002. The sensitivity of DXR for OAP = 1; specificity = 0,95; accuracy = 0,95; positive predictive value = 0,038; negative predictive value = 1; positive likelihood ratio = 20; negative likelihood ratio = 0. Odds ratio = 1:499 odds ratio = 1/24.

Conclusion: The dental radiography shows relative positive predictive validity in determining the possibility of occurring oroantral perforation during tooth extraction – indicating many false positive results. The possibility of OAF during upper posterior tooth extraction is 1 in 500 cases but if dental radiography presents signs of close relationship between tooth root and maxillary sinus this possibility increases for 1:24.

Keywords: Maxillary Sinus; Tooth Extraction; Oroantral Perforation; Dental Radiography

RESUMO

Introdução: Na Cirurgia Oral, a radiografia dentária convencional (DXR) é amplamente utilizada para avaliar a raiz do dente e as estruturas adjacentes. Durante a extração dentária, se a raiz

do dente estiver muito próxima ao seio maxilar, ela pode ser deslocada para o seio maxilar ou uma perfuração oroantral (OAP) pode ser possivelmente estabelecida. Este estudo teve como objetivo determinar a validade da triagem DXR na detecção de achados radiológicos compatíveis com a estreita relação entre a raiz do dente, o seio maxilar e a prevalência de OAP na extração dentária.

Métodos: Este estudo analisou todos os prontuários de indivíduos atendidos na Faculdade de Odontologia da Universidade Estadual de Ponta Grossa - Brasil, nos anos de 2016 e 2017. Os critérios de inclusão foram: prontuários com DXR; prontuário médico com extração dentária posterior superior. Os critérios de exclusão foram prontuários sem DXR; prontuários médicos com extração dentária mandibular; prontuário médico com extração dentária ântero-superior; prontuários médicos sem extração dentária. A estreita relação entre a raiz do dente e o seio maxilar foi avaliada em DXR de dentes posteriores superiores extraídos e a ocorrência de OAP foi verificada clinicamente. A validade preditiva de DXR para OAP foi medida. Foram calculados os valores de sensibilidade, especificidade, valor preditivo positivo e valor preditivo negativo, razão de verossimilhança e razão de chances.

Resultados: A prevalência de OAF = 0,002. A sensibilidade de DXR para OAP = 1; especificidade = 0,95; precisão = 0,95; valor preditivo positivo = 0,038; valor preditivo negativo = 1; razão de verossimilhança positiva = 20; razão de verossimilhança negativa = 0. Razão de chance = razão de chance 1: 499 = 1/24.

Conclusão: A radiografia dentária mostra relativa validade preditiva positiva na determinação da possibilidade de ocorrer perfuração oroantral durante a exodontia - indicando muitos resultados falso-positivos. A possibilidade de OAF durante a extração de dente posterior superior é de 1 em 500 casos, mas se a radiografia dentária apresentar sinais de estreita relação entre a raiz do dente e o seio maxilar, essa possibilidade aumenta para 1:24.

Palavras-chave: Seio Maxilar; Extração de dente; Perfuração Oroantral; Radiografia Dentária

INTRODUCTION

Knowledge of the anatomical relationship between the maxillary sinus floor and the maxillary posterior teeth root tips is important for the preoperative treatment planning of maxillary posterior teeth (1, 2). The root apices of maxillary posterior teeth may well present a close relationship with the sinus floor (3, 4). The first and second molar roots are most commonly in close proximity to the inferior wall of the maxillary sinus, especially in the buccal roots, followed by the third molar and second pre-molars (3, 4). Occasionally, the maxillary canine roof also encroaches upon the sinus (4). The roofs of upper posterior teeth are usually separated from maxillary sinus by various bone thicknesses, but are sometimes separated by the sinus mucosa alone (4).

Surgical removal of upper posterior teeth is a routine procedure in which complications occasionally arise. Oroantral perforation (OAP) might occur after dental extractions, given the anatomical proximity between the upper posterior dental roots and the maxillary sinus. (5). The immediate relationship between the position of the tip of the root and the maxillary sinus is a predictive factor for OAP (5).

The maxillary tooth root and sinus relationship can be assessed using different radiographic techniques. Conventional dental radiographs (DXR) used in dental clinics include mainly intraoral

periapical radiographs and to a lesser extent orthopantomograms. Virtually, every radiographic examination in the dental clinic starts with a periapical radiograph. Periapical radiographs were slightly more reliable than orthopantomograms in determining the relationship between tooth root and maxillary sinus (6).

LOPES et al. 2016 (5), established five radiographic signs of projection of the root apices into the sinus cavity interpreted in the panoramic radiographs: 1) projection of the root apices in the sinus cavity; 2) interruption of the maxillary sinus floor's cortex; 3) lamina dura absent; 4) darkening of the root apical region; 5) upward curving of the sinus floor enveloping the tooth root partially or completely.

XAMBRE, et al. 2016 (3), established the definition of the maxillary sinus pneumatization involving the root of the upper teeth on periapical radiography. When pneumatization of the maxillary sinus is present, two situations may occur. In the first, pneumatization occurs in the region near the tooth root, without actually coming in contact with it. As the radiographic image is two-dimensional, the image of the maxillary sinus floor projects itself over the roots of the posterior maxillary teeth; however, it should be noted that the contour of the maxillary sinus floor remains unaltered, that is, horizontal and slightly curved. In the second, the pneumatization of the real maxillary sinus comes in contact with the dental roots. Thus, the maxillary sinus floor deviates from its linear and horizontal path to bypass the dental root of the posterior teeth, turning on a sinuous contour in the shape of a bell, with a format that is similar to the contour of the root apex. In this scenario, on the periapical radiograph, one can observe that the radiopaque line of the contour of the maxillary sinus floor merges with the radiopaque line of the lamina dura that bypasses the dental apex, as if both were a single sinuous and radiopaque line in close contact with the root apex.

The evaluation of the quality of diagnostic tests is a topic of interest in clinical and epidemiological researches. The performance of a diagnostic test depends on the reliability of the exam, the reproducibility, and on the validity of the exam, the accuracy.

This study aimed to determine the validity of DXR screening in detecting radiological findings compatible with the close relationship between the tooth root, the maxillary sinus and the prevalence of OAP in dental extraction.

METHODS

This study examined all medical records of individuals treated at the Division of Oral and Maxillofacial Surgery, Dental School of Ponta Grossa State University – Paraná –Brazil, in 2016 and 2017. The inclusion criteria were: medical records with DXR; medical records with upper posterior tooth extraction. The exclusion criteria were medical records without DXR; medical records with mandibular tooth extraction; medical records with upper anterior tooth extraction; medical records without tooth extraction.

The close relationship between the tooth root and the maxillary sinus were evaluated in DXR of upper posterior teeth extracted using the criteria established by LOPES, et al. 2016 (5) and XAMBRE, et al. 2016 (3). The DXR was classified in dichotomic variable according to the relationship between the tooth extracted and the maxillary sinus.

The occurrence of OAP was clinically verified. Clinically, a large OAP is easily seen on inspection. Presence of OAP appears as a whistling sound as air passes down the fistula into the oral cavity. It can

also be seen as air bubbles, blood or mucoid secretion around the orifice. The escape of air through the perforation can be tested by Valsalva maneuver. A mouth mirror placed at OAP causes mirror fogging. The clinical diagnostic is the “gold standard” for OAP. In cases with OAP the immediate surgical treatment was provided.

The information obtained was conventionally summarized in a confusion matrix. The predictive validity of DXR for OAP was measured. The values of real prevalence estimated prevalence, sensitivity, specificity, positive predictive value, negative predictive value, accuracy, likelihood ratio and odds ratio were calculated.

RESULTS

The prevalence of oroantral perforation was evaluated in 498 upper posterior teeth extraction performed in Division of Oral and Maxillofacial Surgery, Dental School Ponta Grossa State University in 2016 and 2017.

In 2016, it were extracted 236 mandibular teeth and 259 maxilar teeth ; the radiography exam demonstrated 17 teeth with roots in close relationship with maxillary sinus; nonclinical oroantral perforation was reported. In 2017, it were extracted 181 mandibular teeth and 239 maxilar teeth; the radiography exam demonstrated 9 teeth with roots in close relationship with maxillary sinus; only one clinical oroantral perforation was reported.

Absolute and relative frequency data were demonstrated in confusion matrix. The true positives were 0,2%; false positive 5,0%; true negative 94,8%; false negative 0% (Table 1).

Table 1- Absolute and Relative Frequency in confusion matrix.

Oroantral Perforation during tooth extraction			
Close Relationship in DXR	Presence (relative frequency)	Absent (relative frequency)	Total
Yes Test positive	1 (0,2%) True positives	25 (5,0%) False positive	26
No Test negative	0 (0%) False negative	472 (94,8%) True negative	472
Total	1	497	498

The results demonstrated that the real prevalence of OAP clinically identified and management during tooth extraction was 0,002 and the estimated prevalence was 0,052; sensitivity 1; specificity 0,949; positive predictive value 0,038; negative predictive value 1; accuracy 0,949; incorrect classification 0,05; positive likelihood ratio 20; negative likelihood ratio 0; Odds ratio OAP in upper posterior teeth extractions = 1:499; Odds ratio AOP in upper posterior teeth extractions with DXR show close relationship between root and maxillary sinus = 1:24 (Table 2).

Table 2.

Real Prevalence	$(\text{true positive} + \text{false negative})/n$ $(1+0)/(1+25+0+472)$	0,002
Estimated Prevalence	$(\text{true positive} + \text{false positive})/n$ $(1+25)/(1+25+0+472)$	0,052
Sensitivity	$\text{true positive}/ (\text{true positive} + \text{false negative})$ $1/(1+0)$	1 continua

conclusão

Specificity	$\text{true negative} / (\text{true negative} + \text{false positive})$ $472 / (25+472)$	0,949
Positive Predictive Value	$\text{true positive} / (\text{true positive} + \text{false positive})$ $1 / (1+25)$	0,038
Negative Predictive Value	$\text{true negative} / (\text{false negative} + \text{true negative})$ $472 / (0+472)$	1
Accuracy	$(\text{true positive} + \text{true negative}) / n$ $(1+472) / (1+25+0+472)$	0,949
Incorrect classification	$(\text{false positive} + \text{false negative}) / n$ $(25+0) / (1+25+0+472)$	0,050
Positive likelihood ratio	$(\text{Sensitivity}) / (1 - \text{Specificity})$ $[1 / (1+0)] / [1 - (472 / (25+472))]$	20
Negative likelihood ratio	$(1 - \text{sensitivity}) / \text{Specificity}$ $[1 - (1 / (1+0))] / (472 / (25+472))$	0
Odds ratio OAP in upper posterior teeth extractions	$\text{Probability} / 1 - \text{probability}$ $(1/498) / (1 - (1/498))$	1/499
Odds ratio AOP in upper posterior teeth extractions with DXR show close relationship between root and maxillary sinus	$\text{Probability} / 1 - \text{probability}$ $(1/25) / (1 - 1/25)$	1/24

DISCUSSION

In the present study, we investigated the predictive validity of the dental radiography for oroantral perforation during tooth extraction. In all cases, the dental radiography showed the relationship of the proximity or distance of dental roots with the maxillary sinus floor. However, the radiography findings overestimated the possibility of the oroantral communication. The false positive prediagnostic was estimated in 5,0%.

In this study, the incidence rate of oroantral perforation is low and less than in other reports. Lim et al. (2012) (7) reported the incidence of oroantral perforation in upper third molar extraction to be range 0.9 %. Rothamel et al (2007) (8) showed the incidence of oroantral perforation > 3mm in upper wisdom teeth surgery to be range 2,18 %. These studies evaluated specifically oroantral communication in maxillary third molar extractions.

The relationship between the roots of the maxillary posterior teeth and the maxillary sinus has been assessed by computed tomography (CT). Kwak et al. (2004) (4), using CT images, proposed a classification for vertical relationship between maxillary posterior teeth and maxillary sinus floor, level I to level V, where the higher level indicates how close the roots are to the maxillary sinus Estrela et al. (2016) (9) considered that even with the protrusion of the roots into the maxillary sinus the presence of cortical bone and the mucosa overlying the maxillary sinus floor must be investigated.

Hassan et al. (2010) (10) investigated the reliability of periapical radiographs and orthopantomograms for exact detection of tooth root protrusion in the maxillary sinus by correlating the results with cone beam computed tomography and concluded that both periapical radiographs and orthopantomograms are not reliable in determining the exact relationship between the apex

of tooth root and the maxillary sinus floor. Periapical radiography is slightly more reliable than orthopantomography in determining this relationship.

Several previous studies have shown the anatomical relationship between the dental roots and the maxillary sinus through computed tomography (11-19). However, CT in Brazil is not the primary exam considered for diagnosis due its high costs and radiation doses (3).

Sharan et al. (2006) (20) showed conventional radiographic techniques are limited in their ability to determine the relationship between the root apices and the surrounding bucco-palatal alveolar bone. Evaluation of panoramic radiographic images might result in overestimation of root length as well as the incidence of root protrusion into the sinus.

Xambre et al. (2016) (3), coined the term 'alveolar dome', referring to the anatomical projection of the root into the floor of the maxillary sinus, seen through digital periapical radiographs. The maxillary first and second molars presented a greater prevalence of alveolar domes, especially in the buccal roots, followed by the third molars and second pre-molars.

The relationship between radiographic findings and the occurrence of oroantral fistula is controversial. Hasegawa et al. (2016) (21) analyzed, in a quantitatively study, various risk factors for oroantral perforation during maxillary third molar extraction. Performance of an incision, mesioangular tooth angulation, and significant superimposition of the roots of all posterior maxillary teeth with the sinus floor were all identified as risk factors with significant association to an outcome of oroantral perforation. Iwata et al. (2021) (22) concluded that is unclear to check whether the number of roots is one and the apex of one root is projecting into the maxillary sinus in CT findings, is useful for the prediction.

The radiographic findings, including CT images, perhaps are not the only predictive determinants of OAP. Other factors may be associated with OAP. The oroantral communication is not characterized by images but is a clinical condition. Diagnosis of an oroantral communication can be made in several clinical ways. The first is to examine the tooth once it has been removed. If a section of bone is adherent to the root ends of the tooth, the surgeon should assume that a communication between the sinus and mouth exists. If little or no bone adheres to the molars, a communication may exist anyway. Some advocate using the nose-blowing test to confirm the presence of a communication (23). This test involves pinching the nostrils together to occlude the patient's nose and asking the patient to blow gently through the nose while the surgeon observes the area of the tooth extraction. If a communication exists, there will be passage of air through the tooth socket and bubbling of blood in the socket area.

In the absence of any infection of maxillary sinus, the defects which are smaller than 2 mm can heal spontaneously following the blood clot formation and secondary healing (24). However, if the opening between the mouth and sinus is of moderate size (2 to 4 mm), additional measures should be taken to help ensure the maintenance of the blood clot in the area. If the sinus opening is large (≥ 5 mm), the surgeon should consider having the sinus communication repaired with a flap procedure (25).

No previous studies have evaluated the statistical performance measures of conventional dental radiographs for oroantral communication. and in this study it is used the clinical diagnostic parameter of oroantral communication as the standard for comparison.

However, this study has some weaknesses. First, there is a possibility of unknown confounding factors because this is a retrospective study. Second, the tooth extractions were performed at a

general dental school so the extractions may have been less complex. Third, it is not clear whether oroantral perforations without clinical significance (< 2mm) occurred. Fourth, the relationship between radiographic findings indicating proximity of tooth roofs with maxillary sinus floor and the clinical occurrence of oroantral communication is controversial. Fifth, there may be more factors that affect clinical OAP such as race (22), age (8, 19, 21), facial biotype (26, 27) and surgical technique adopted (28).

CONCLUSION

The relationship between radiographic findings and the occurrence of oroantral perforation is controversial. The dental radiography shows relative positive predictive validity in determining the possibility of occurring oroantral perforation during tooth extraction – indicating many false positive results. The possibility of OAP during upper posterior tooth extraction is 1 in 499 cases, but if dental radiography presents signs of close relationship between tooth root and maxillary sinus this possibility increases for 1:24.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest related to this study.

AUTHOR'S CONTRIBUTIONS

A.T. contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript

K. N. T. F. contributed to the acquisition of data.