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CLASSIFICAÇÃO TOMOGRÁFICA DAS RAÍZES DO TERCEIRO MOLAR SUPERIOR ASSOCIADA COM O ROMPIMENTO DA CORTICAL ÓSSEA DO SEIO MAXILAR PÓS EXODONTIA

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Dissertação apresentada ao Programa de Pós-graduação em Clínica Odontológica, da Faculdade de Odontologia da Universidade Federal de Juiz de Fora, como requisito parcial para obtenção do título de Mestre em Clínica Odontológica. Área de concentração em Clínica Odontológica.

Orientadora: Profª. Drª. Neuza Maria Souza Picorelli Assis

Orientadora: Profª. Drª Karina Lopes Devito

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Aprovada em: _____ de _____ de 2016.

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RESUMO

Este estudo estabeleceu uma alternativa de classificação entre as raízes e o seio maxilar para estimar as chances de perfuração da cortical óssea. Foram analisadas imagens de Tomografias Computadorizadas de Feixe Cônico pré e pós operatórias de 70 Terceiros Molares Superiores, do banco de dados da Clínica de Radiologia da FO/UFJF. O grupo mais frequente de cada classificação foi comparado aos demais tipos agrupados quanto ao rompimento da cortical do seio maxilar. Foi aplicado o Teste Qui Quadrado para comparação de proporções e para mensurar a chance de perfuração da cortical do seio maxilar, utilizou-se Razão de Chances (Odds Ratio) com intervalo de confiança de 95%. A análise estatística foi realizada pelo programa SPSS versão 23.0 (SPSS, Chicago, IL, EUA). Admitiu-se nível de significância de 5% e a média de idade foi de 22,54 anos. Com relação às raízes 25 (35,71%) eram fusionadas e 45 (64,29%) separadas, totalizando 160 raízes. Constatou-se o rompimento da cortical do seio maxilar pós exodontia em 21 dentes, totalizando 30% da amostra. Na associação entre a classificação da posição radicular em relação à visualização do seio maxilar com o rompimento da cortical óssea, o Tipo II foi o que mais provocou o rompimento e quando comparado aos demais tipos agrupados, apresentou associação significativa (p=0,022). Na avaliação de razão de chances (Odds Ratio), encontrou-se uma chance três vezes maior de perfuração da cortical quando a raiz do Terceiro Molar Superior enquadrou-se no Tipo II. Na classificação de proximidade de contato com a cortical do seio maxilar, as raízes fusionadas do grupo G3 foram as que apresentaram rompimento com maior frequência, contudo não foi uma diferença estatisticamente significativa. Entre as raízes separadas, houve associação significativa com o rompimento na posição G4, somente para a disto vestibular (p=0,008). O grupo G4, mais frequente relacionado ao rompimento, foi comparado com todas as demais raízes agrupadas (incluindo as fusionadas) e os resultados foram significativos. Observamos neste estudo que tanto as raízes fusionadas quanto as separadas, dentro ou fora do seio maxilar, podem provocar o rompimento da cortical do seio maxilar, sendo de fundamental importância usar a tecnologia das Tomografias Computadorizadas de Feixe Cônico para avaliações de riscos, a fim de se precaver quanto a complicações, como a comunicação buco sinusal e a sinusite maxilar.

PALAVRAS-CHAVE: Terceiro molar superior; Tomografia Computadorizada de Feixe Cônico; Seio maxilar.

ABSTRACT

This study established an alternative classification, between the roots and the maxillary sinus, to evaluate the chances of cortical bone perforation. Pre- and post-operative Cone Beam Computed Tomography images of 70 Upper third molar were analyzed, from the database of the Radiology Clinic, *FO / UFJF*. The most frequent group for each classification was compared to the remaining types, grouped by the cortical bone breach of the maxillary sinus (MS). The Chi-Square test was used to compare proportions, and to measure the chance of perforation of the MS cortical bone, the Odds Ratio with a 95% confidence interval was used. Statistical analysis was carried out using SPSS version 15.0 (SPSS, Chicago, IL, USA). A 5% significance level was assumed and the mean age was 22.54 years. Regarding the roots, 25 (35.71%) were fused, and 45 (64.29%) separate, totaling 160 roots. MS cortical breach was found after extraction in 21teeth, totaling 30% of the sample. In the association between the classification of the root position in relation to the MS visualization, with the breach of the sinus cortical bone, Type II was the one that most often provoked the breach, and when compared to the other grouped types, showed a significant association ($p = 0.022$). In assessing the odds ratio, a three times greater chance of cortical perforation was found when the Upper third molar root belonged to Type II. In the classification for proximity of contact with the cortical bone of the SM, the fused roots of the G3 group showed a breach more often, but it was not a statistically significant difference. Among the separate roots, there was a significant association with a breach for the G4 position, only for the disto-vestibular ($p = 0.008$). The G4 group, most frequently related to a breach, was compared with all the other grouped roots (including fused roots), and the results were significant. We observed in this study that both fused roots and separate roots, inside or outside the sinus, can cause a breach of maxillary sinus cortical bone, and that the use of Cone Beam Computed Tomography technology is fundamentally important for risk assessments, in order to avoid complications such as oro-antral communication and maxillary sinusitis.

KEYWORDS: Upper third molar; Cone Beam Computed Tomography; Maxillary sinus.

SUMÁRIO

1 INTRODUÇÃO

A exodontia dos terceiros molares é o procedimento mais comum realizado na cirurgia oral. Exames pré-operatórios cuidadosos, incluindo o uso de tomografias computadorizadas (TC), auxiliam no planejamento e na previsão dos riscos relacionados com as intervenções cirúrgicas (NAKAMORI; TOMIHARA; NOGUCHI, 2014).

Procedimentos cirúrgicos apropriados devem ser determinados com bases em conclusões de exames pré-operatórios que avaliem criticamente a morfologia dos terceiros molares e sua relação com estruturas adjacentes (NAKAMORI; TOMIHARA; NOGUCHI, 2014). Neste cenário, a Tomografia Computadorizada de feixe Cônico (TCFC) tem demonstrado ser uma importante ferramenta de avaliação para determinar a relação espacial entre as raízes e o assoalho do seio maxilar (SM), pois fornece informações seguras sobre estruturas ósseas, sem distorção e sobreposição das imagens (LIM; WONG; ALLEN, 2012; HOWE, 2009). O número e a forma das raízes também podem ser avaliados pela TCFC e deve ser recomendado para os cirurgiões que buscam informações para planejamento pré operatório (NAKAMORI; TOMIHARA; NOGUCHI, 2014).

O conhecimento da localização e contorno das estruturas anatômicas da região posterior da maxila é de suma importância para os procedimentos cirúrgicos de exodontia (EBERHARDT; TORABINEJAD; CHRISTIANSEN, 1992). Sobre a extração do terceiro molar superior (TMS), especificamente, existem relatos de baixa incidência de complicações, o que pode explicar a inexistência de uma abordagem preventiva para sua extração (NAKAMORI; TOMIHARA; NOGUCHI, 2014). No entanto, não é raro relatos de intercorrências que frequentemente necessitam de tratamentos complexos (CARVALHO; ARAUJO FILHO; VASCONCELOS, 2013).

Uma das complicações decorrentes das extrações dos molares superiores é a lesão de estruturas ósseas como a perfuração do assoalho do SM (LIM; WONG; ALLEN, 2012; NAKAMORI; TOMIHARA; NOGUCHI, 2014). Este é o primeiro dos seios paranasais a desenvolver-se e seu crescimento termina com a erupção do TMS por volta dos 20 anos de idade (MISCH, 1999). O assoalho é formado pelo processo alveolar da maxila estendendo-se entre dentes ou raízes adjacentes que,

ocasionalmente, se projetam para o seu interior (EBERHARDT; TORABINEJAD; CHRISTIANSEN, 1992).

A perfuração da cortical do SM pode evoluir para uma infecção se não for devidamente tratada (LIM; WONG; ALLEN, 2012). No caso de rompimento da cortical com fenestração da membrana, poderá ocorrer o desenvolvimento de sinusite aguda ou crônica, com risco de obstrução do óstio sinusal (VOGIATZI et al., 2014). Outra das intercorrências pode ser a comunicação buco sinusal, caracterizada pela existência de uma descontinuidade entre a cavidade oral e o SM, como resultado da perda de tecido mole e tecido duro que os separam. A persistência da comunicação buco sinusal pode provocar uma reação inflamatória crônica da membrana do SM com fístula permanente, aumentando ainda mais o risco das sinusites (SANTAMARIA et al., 2006).

A incidência de comunicação buco sinusal em pacientes submetidos à extração do TMS ainda não é clara e os pacientes com maior risco de desenvolver esta complicação precisam ser identificados (SANTAMARIA et al., 2006). Por estas prerrogativas, é essencial ter-se em conta a relação exata das raízes do TMS com a cortical óssea do assoalho do SM (KILIC et al., 2010). Existem alguns sistemas que classificam os molares superiores de acordo com a posição das raízes em relação ao SM, como nos estudos de Ariji et al. (2006) e Pagin et al. (2013). Entretanto, esses estudos não incluíram a classificação das raízes do TMS. Também não se tem conhecimento na literatura pesquisada de nenhum outro estudo que tenha avaliado, através de imagens tomográficas, o rompimento da cortical do SM após exodontia.

Assim, este estudo se propôs a realizar uma classificação da posição das raízes do TMS em relação à proximidade e visualização do SM através de TCFC e verificar uma associação com o rompimento da cortical óssea após exodontia.

2 PROPOSIÇÃO

O propósito do presente estudo foi de avaliar tomograficamente a relação das raízes do Terceiro Molar Superior com o Seio Maxilar e investigar a influência dessa associação com o rompimento da cortical óssea do assoalho do seio após exodontia.

3 MATERIAL E MÉTODOS

3.1 DESENHO DO ESTUDO E CARACTERIZAÇÃO DA AMOSTRA

Trata-se de um estudo transversal em que foram analisadas imagens em cortes axiais, sagitais e coronais de TCFC antes e depois da exodontia de 70 terceiros molares superiores. Os exames foram obtidos do banco de dados da Clínica de Radiologia da Faculdade de Odontologia da Universidade Federal de Juiz de Fora (FO/UFJF). Esse estudo foi aprovado pelo Comitê de Ética em Pesquisa da UFJF sob o número 699.347.

3.1.1Critérios de inclusão e exclusão

Foram incluídos exames de TCFC pré e pós-operatórias de indivíduos com idade entre 18 e 30 anos que foram submetidos à exodontia do TMS. Foram excluídos os exames de pacientes com ausência de algum dos molares superiores, com histórico de cirurgia maxilo-mandibular e anomalias crânio-faciais e pacientes submetidos a tratamento ortodôntico.

3.2 AVALIAÇÃO DOS DADOS TOMOGRÁFICOS

Todas as imagens foram adquiridas pelo tomógrafo i-CAT (*Imaging Sciences International*, Hatfield, PA, EUA) operando a 120 kV e 3-8 mA, voxel de 0,25 mm, tempo de rotação de 26,9s e FOV de 10 cm e, posteriormente, reconstruídas no *software iCat Vision*. As imagens foram avaliadas em reconstruções multiplanares, de forma independente, por dois cirurgiões dentistas devidamente treinados e calibrados, com experiência em imagens tomográficas. Após 15 dias, 20% da amostra foi reavaliada para cálculo da concordância intra examinador.

3.2.1 Classificação das raízes em relação ao seio maxilar

3.2.1.1 Classificação de Ariji et al. (2006) modificada

Para determinar a relação entre as raízes do TMS com o SM foi utilizada a classificação de Ariji et al. (2006) modificada para incluir dentes com raízes separadas e fusionadas. Para realização desta classificação foi utilizado o corte axial mais inferior em que o SM aparece pela primeira vez (Figura 1A). Definido o corte axial mais inferior, a relação do TMS com o SM foi determinada pelo corte sagital correspondente (Figura 1B).

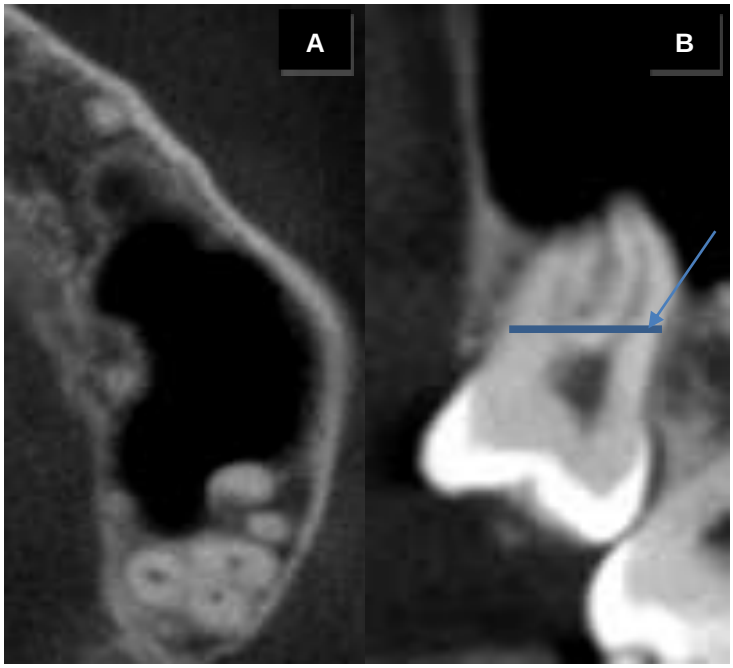

Figura 1. A. Corte axial utilizado para classificação da raiz em relação à visualização do SM; **B.** Corte sagital correspondente. Seta: Região em que o seio maxilar é visto pela primeira vez.
Fonte: Faculdade de Odontologia/UFJF (2016).

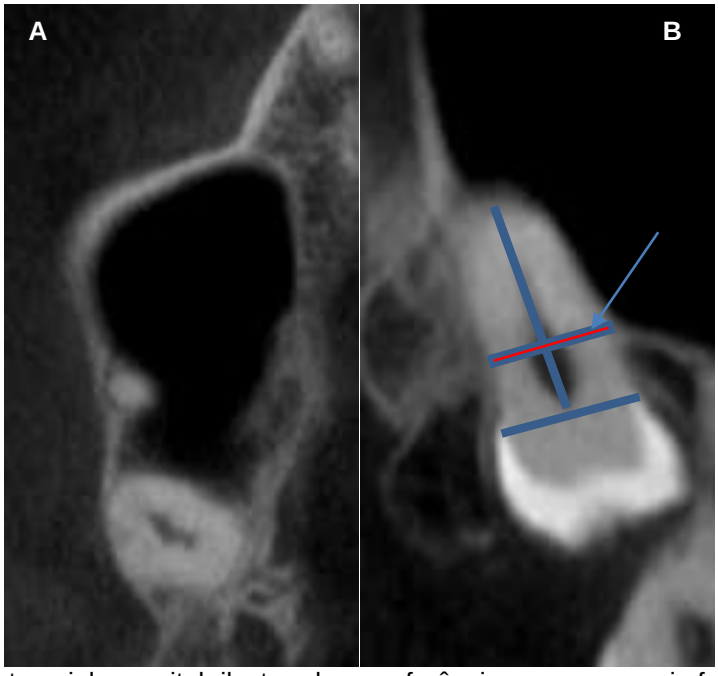

Figura 2: A e B. Corte axial e sagital, ilustrando as referências para uma raiz fusionada. Seta: Linha superior do terço cervical da raiz para substituir o nível da bifurcação.
Fonte: Faculdade de Odontologia/UFJF (2016).

Raízes Fusionadas: A porção mais inferior do SM pode ser visualizada ao nível do terço cervical. As raízes foram divididas em terços no corte sagital correspondente para substituir a referência da bifurcação não existente nestes dentes (Figura 2A e B).

Tipo I: A porção mais inferior do SM pode ser visualizada ao longo das raízes, a partir do nível da bifurcação (Figura 3A e B).

Tipo II: A porção mais inferior do SM pode ser visualizada em contato com o ápice da raiz de maior comprimento do TMS, não podendo ser visto ao nível da bifurcação (Figura 3C e D), nem na linha superior do terço cervical (raízes fusionadas).

Tipo III: A porção mais inferior do SM só pode ser visualizada acima do ápice da raiz de maior comprimento do TMS nas raízes separadas (Figura 3E e F) e nas fusionadas.

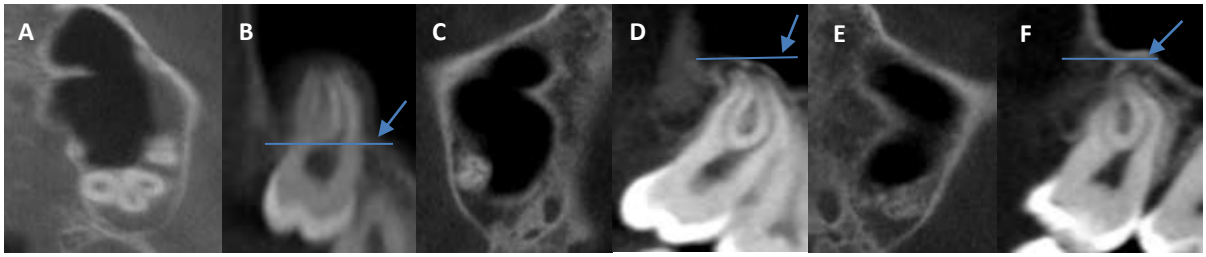

Figura 3. A e B. Corte axial e sagital de TCFC para classificação radicular em relação ao seio maxilar ilustrando um caso do Tipo I. Linha de bifurcação da raiz; **C e D**. Corte axial e sagital de TCFC ilustrando um caso do Tipo II. Linha acima do ápice da raiz de maior comprimento; **E e F**. Corte axial e sagital de TCFC ilustrando um caso do Tipo III. Linha acima do ápice da raiz.
Fonte: Faculdade de Odontologia/UFJF (2016).

3.2.1.2 Classificação de Pagin et al. (2013) modificada

As raízes do TMS foram classificadas quanto a sua proximidade de contato em relação ao SM nos cortes coronais, definidos a partir de cortes sagitais e axiais, segundo a classificação de Pagin et al. (2013) modificada. O corte coronal correspondente deveria apresentar a imagem do ápice de cada raiz (Figuras 4A, 4B e 4C), incluindo as fusionadas.

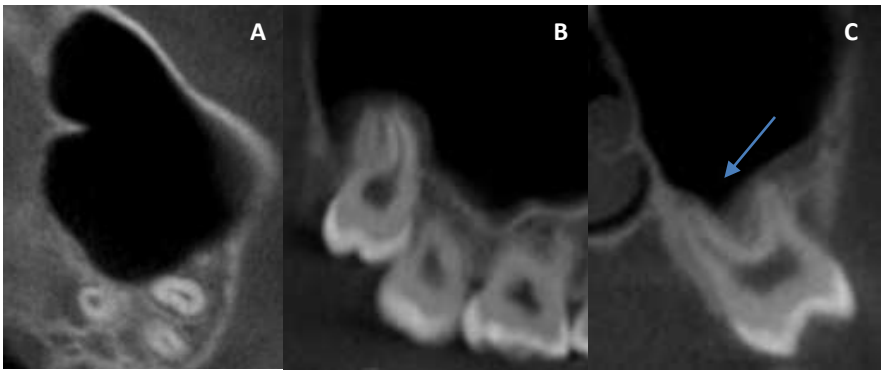

Figura 4. A e B. Cortes axial e sagital utilizados para definição do Corte coronal; **C**. Corte coronal correspondente, Identificando o tipo G4.
Fonte: Faculdade de Odontologia/UFJF (2016).

G1: Sem contato da raiz com o osso cortical do SM (Figura 5A).

G2: Íntimo contato com a cortical óssea, mas sem protrusão da raiz para o interior do SM (Figura 5B).

G3: Íntimo contato com a cortical óssea e protrusão da raiz para o interior do SM com evidência da cortical óssea (Figura 5C).

G4: Íntimo contato com a cortical óssea e protrusão da raiz para o interior do SM sem evidência da cortical óssea (Figura 5D).

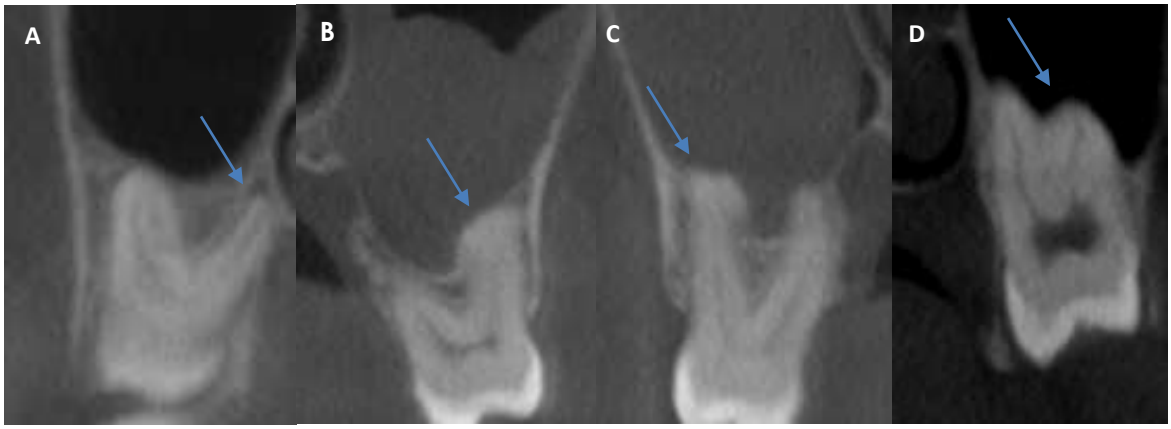

Figura 5. A. Corte coronal correspondente, identificando o grupo G1; **B**. Imagem do Corte coronal correspondente, identificando o grupo G2; **C**. Imagem do Corte coronal correspondente, identificando o grupo G3; **D**. Imagem do Corte coronal correspondente, identificando o grupo G4.
Fonte: Faculdade de Odontologia/UFJF (2016).

3.2.2 Avaliação do rompimento da cortical do seio maxilar

Foram avaliadas imagens de TCFC realizadas no pós-operatório dos pacientes submetidos à exodontia do TMS. Foi avaliada a integridade da cortical óssea do SM nos cortes sagitais sequenciais na região do TMS extraído. Imagens de descontinuidade da cortical óssea do assoalho do SM na região correspondendo ao TMS receberam a classificação “sim” para o rompimento da cortical do SM. As imagens que demonstraram a integridade da cortical óssea receberam a classificação “não” para o rompimento da cortical do SM (Figuras 6A e B).

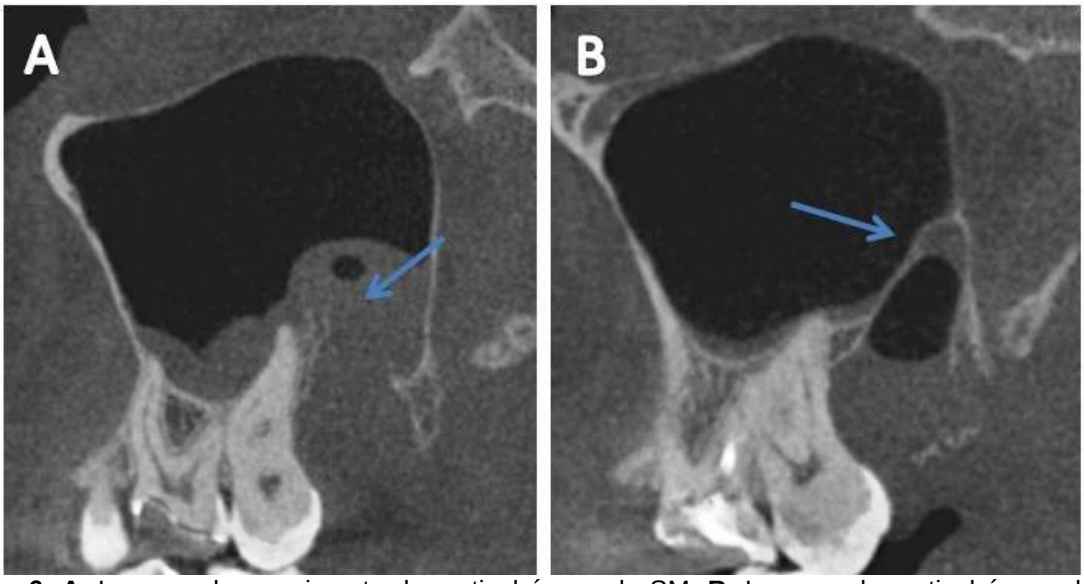

Figura 6. A. Imagem do rompimento da cortical óssea do SM. **B**. Imagem da cortical óssea do SM íntegra.
Fonte: Faculdade de Odontologia/UFJF (2016).

3.3 ANÁLISE DOS DADOS

Foram determinadas as frequências de cada uma das classificações utilizadas. O grupo mais frequente de cada classificação foi comparado aos demais tipos agrupados quanto ao rompimento da cortical do SM.

Foi aplicado o teste Qui Quadrado para comparação de proporções e teste de Fischer, quando necessário. Para mensurar a chance de perfuração da cortical do SM, utilizou-se Razão de Chances (OddsRatio) com intervalo de confiança de 95%. A análise estatística foi realizada pelo programa SPSS versão 23.0 (SPSS, Chicago, IL, EUA). Admitiu-se nível de significância de 5%.

4 ARTIGO

O artigo abaixo está apresentado nas normas do periódico Elsevier Editorial System(tm) for Journal of Oral and Maxillofacial Surgery Manuscript Draft, classificado no Qualis da CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), na Área de Avaliação de Odontologia, como A1 (ANEXOS B e C).

Association between maxillary third molar roots and perforation of cortical sinus bone after extraction: a tomographic study

Article Type: Full Length Article
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Abstract

Purpose: To evaluate the position of maxillary third molar (MTM) roots in relation to the maxillary sinus (MS) through cone beam computed tomography (CBCT) images and to verify an association with the perforation of cortical bone after extraction.

Methods: Pre- and post-operative CBCT images of 70 MTMs were analyzed. To determine the relationship between the MTM roots and the MS, two classifications were used: modified Ariji et al. classification (Types I, II, and III) and modified Pagin et al. classification (G1, G2, G3, and G4). The most frequent group for each classification was compared (Chi-Square test), with the remaining types by the cortical bone perforation of the MS. To measure the chance of perforation of the MS cortical bone the odds ratio was used.

Results: For the roots of the 70 MTMs evaluated, 25 (35.71%) were fused and 45 (64.29%) were separated, totaling 160 roots. MS cortical perforation was found after extraction in 21 (30%) teeth. Teeth classified as Type II (MS can be seen in contact with the apex of the longest MTM root) were the most often associated with the perforation of the MS ($p = 0.022$). In the modified Pagin et al. classification, there was a significant association with a perforation for the G4 (root protrusion into the MS without evidence of cortical bone) but only for the disto-vestibular roots ($p = 0.008$). The G4 group, which was most frequently related to a perfuration, was compared with all of the other grouped roots, and the results were significant.

Conclusion: The roots of the MTM can be classified by CBCT regarding the proximity to the MS. This technology can be used to assess risks of cortical perforation of the MS in MTM surgery to prevent possible complications such as oro-antral communication and maxillary sinusitis.

Dear Prof. Devito,

Your submission entitled "Association between maxillary third molar roots and perforation of cortical sinus bone after extraction: a tomographic study" has been been assigned the following manuscript number: **JOMS-D-16-01145.**

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Kind regards,

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Editorial Assistant
Journal of Oral and Maxillofacial Surgery

Association between maxillary third molar roots and perforation of cortical sinus bone after extraction: a tomographic study

Introduction

Third molar extraction is the most common procedure in oral surgery. Most studies are focused on mandibular third molar surgery because most maxillary third molar (MTM) extractions have a low degree of difficulty. This may be the reason why the preventive aspect of measuring surgical difficulty is frequently not considered in MTM surgery, which is reflected in the reports of severe complications that often require complex management.[1]

Careful preoperative exams, including the use of computed tomography (CT), assist in planning and in predicting the risks related to this surgery. Preoperative assessment should include a detailed morphologic analysis of the third molar and its relationship to adjacent structures and surrounding tissues.[2] Knowledge about the location and form of the anatomical structures of the posterior maxillary region is important for surgical extraction procedures. Thus, cone beam computed tomography (CBCT) has proven to be an important assessment tool for determining the number, shape, and relationship between roots and the maxillary sinus (MS) floor because it provides an accurate 3-dimensional view without the distortion and superimposition caused by teeth and the surrounding structures.[3,4]

One of the complications resulting from the extraction of MTMs is damage to bone structures, such as perforation of the MS floor.[2,5] This is the first of the paranasal sinuses to develop, and its growth ends with eruption of the MTM at approximately 20 years of age. The floor is formed by the alveolar process of the maxilla extending between adjacent teeth or roots, which occasionally protrude into it.[6] Cortical perforation of the sinus can develop into an infection if not properly treated.[5] In the case of a cortical perforation with fenestration of the membrane, acute or chronic sinusitis may develop with a risk of sinus ostium blockage.[7] Another complication can be oro-antral communication, characterized by the existence of a discontinuity between the oral cavity and the maxillary sinus as a result of the loss of soft and hard tissues that separate them. The persistence of oro-antral communication can cause a chronic inflammatory reaction of the sinus membrane with a permanent fistula, which further increases the risk of sinusitis.[8]

The incidence of oro-antral communication in patients who have undergone third molar extraction is still unclear, and the patients with a higher risk of developing this complication need to be defined.[8] It is thus essential to take into account the precise relationship of MTM roots with the cortical bone of the MS floor.[9] There are some systems that classify the maxillary molars according to the position of the roots in relation to the MS, as in the studies by Ariji et al.[10] and Pagin et al.[4]; however, they did not include MTM root classification. Additionally, in our literature review, no previous CBCT research investigating the perforation of the cortical of the sinus after tooth extraction was found.

Thus, the aim of this study was to perform a classification of the position of MTM roots in relation to the proximity and visualization of the MS through CBCT images and to verify an association between root position and the perforation of cortical bone after extraction.

Material and methods

This is a cross-sectional study that analyzed images in axial, sagittal, and coronal CBCT sections, before and after extraction, of 70 MTMs. The exams were obtained from the database of the Radiology Clinic, School of Dentistry, Federal University of Juiz de Fora (FO/UFJF). This study was approved by the Research Ethics Committee of the UFJF under the number 699.347.

Pre- and post-operative CBCT scans were included from individuals between 18 and 30 years of age who underwent MTM extraction. Exams from patients missing any of the maxillary molars, those who had a history of maxillo-mandibular surgery and craniofacial anomalies, or those who had undergone orthodontic treatment were excluded.

The images were acquired using an i-CAT scanner (Imaging Sciences International, Hatfield, PA, USA) operated at 120 kV and 3-8 mA, 0.25 mm voxels with a rotation time of 26.9 s, and a 10 x 23 cm FOV. The images were reconstructed in the i-CATVision software and evaluated by one dental surgeon who were properly trained and calibrated with experience in CBCT analysis. After two weeks, 20% of the sample was reevaluated to calculate intra-examiner agreement.

Classification of the roots in relation to the maxillary sinus

Modified Ariji et al.[10] classification

To determine the relationship between the MTM roots and the MS, a modified classification by Ariji et al.[10] was used to include teeth with separate and fused roots. To make this classification, the lowest axial section in which the MS first appears (Figure 1A) was used. With the lowest axial section defined, the relationship between the MTM and the MS was determined by the corresponding sagittal section (Figure 1B).

Figure 1

Figure 2

Type I: The lowest portion of the MS can be viewed along the roots, from the level of the furcation (Figures 3A and B). For fused roots: the lowest portion of the MS can be viewed at the level of the cervical third. The roots were divided into thirds in the sagittal section to replace the non-existent furcation reference in these teeth (Figure 2).

Type II: The lowest portion of the MS can be seen in contact with the apex of the longest MTM root and cannot be seen at the level of the furcation (Figures 3C and D) nor on the top line of the cervical third (fused roots).

Type III: The lowest portion of the MS can be seen only above the apex of the longest MTM root in the separate roots (Figures 3E and F) and the fused roots.

Figure 3

Modified Pagin et al.[4] classification

The MTM roots were classified by their contact proximity to the MS in the coronal sections, according to the modified Pagin et al.[4] classification. The evaluated coronal section should present the image of the apex of each root, including fused roots.

G1: No contact of the root with the cortical bone of the MS (Figure 4A).

G2: Close contact with the cortical bone but without root protrusion into the MS (Figure 4B).

G3: Close contact with the cortical bone and root protrusion into the MS with evidence of cortical bone (Figure 4C).

G4: Close contact with the cortical bone and root protrusion into the MS without evidence of cortical bone (Figure 4D).

Figure 4

CBCT postoperative images were evaluated for patients who had undergone MTM extraction. MS cortical bone integrity was evaluated in sequential sagittal sections in the MTM extraction region. Images of discontinuity of the cortical plate of the MS floor, in the region corresponding to the MTM, received a "yes" classification for MS cortical perforation. The images that demonstrated integrity of the cortical bone received a "no" classification for maxillary sinus cortical perforation (Figure 5).

Figure 5

Data analysis

The frequency of each classification used was determined. The most frequent group of each classification was compared with the remaining types grouped with regard to MS cortical perforation.

When necessary, the Chi square test and Fisher’s exact test were used to compare proportions. To measure the likelihood of cortical perforation of the MS, the

odds ratio was used with a 95% confidence interval. Statistical analysis was performed using SPSS, version 15.0 (SPSS, Chicago, IL, USA). A 5% significance level was assumed.

Results

The minimum patient age was 18 years, and the maximum was 28, with a mean of 22.54 years (SD ± 2.75 years). There were 22 teeth from males (31.4%) and 48 from females (68.5%). Of the 70 MTMs, 37 (52.8%) were from the right side and 33 (47.1%) from the left. The total number of roots was 160, with 25 (15.62%) fused and 135 (84.38%) separate (disto-vestibular, mesio-vestibular, and palatine). Moderate intra examiner agreement (Kappa 0.47) was achieved for the modified Ariji et al.[10] classification and substantial agreement (Kappa 0.72) for the modified Pagin et al.[4] classification.

The different root classifications were associated with perforation of the MS cortical bone. The occurrence of a cortical perforation was observed in 21 sites (30%). Table 1 shows the distributions of cortical perforation in the three different classification levels in relation to the MS visualization.

Table 1

In this classification, Type II provoked the perforation most frequently and presented a significant association with perforation when compared with the other grouped types ($p = 0.022$). In the odds ratio assessment, a three times greater chance of cortical perforation was found when the MTM root was Type II (OR = 3.62; 95% CI: 1.14 - 11.43).

In the classification of closeness of contact with the cortical bone of the MS, the fused roots of the G3 group presented the highest frequency of perforation.

However, this was not a statistically significant difference (Table 2).

Table 2

Among the separate roots, the position that most often caused a perforation was G4. However, there was a significant association with the perforation only for the disto-vestibular roots (p = 0.008). Table 3 shows the distributions of cortical perforation for the three different roots in relation to the classification of their proximity to the cortical bone of the MS.

Table 3

The G4 group, which was most frequently related to the perforation, was compared with all of the other root groupings (including fused roots), and the results were significant (Table 4). The odds ratio assessment for the separate roots is presented in Table 5.

Table 4

Table 5

Discussion

This study classified the relation of MTM roots with the MS and associated this classification with the perforation of cortical bone after extraction. It is essential for clinicians to be aware of the exact relationship between the apical roots of the maxillary teeth and the MS floor because of the implications this can have on surgical procedures[9] and to minimize the risk of creating communication between the oral cavity and the MS.[11] CBCT images of this study demonstrated the occurrence of cortical bone sinus perforation after third molar extraction. Thus, we can consider the

importance of using pre-operative tomography exams for surgical planning of the third molar extraction.

For this study, a tomographic classification of the roots of the MTM in relation to the MS was performed. The assessment criteria were a modification of the classification by Ariji et al.[10] and Pagin et al.[4]. This existing classification included the maxillary premolar and molar roots and did not evaluate MTM roots. On the contrary, our study evaluated exclusively the MTM roots, including the separated and fused roots. In the first modified classification, the reference is the point at which the sinus first appears alongside the root from a horizontal perspective. In the second modified classification, the reference is to the cortical bone of the sinus in relation to the root apex in a vertical perspective. The purpose of this modified classification is to provide accurate data that can be useful in considering the possibility of cortical perforation of the MS. Based on this, appropriate surgical planning can be achieved and intraoperative techniques can be used both to minimize the risk of accidents and complications as well as to reverse predictable or inevitable damage.

To perform surgical interventions in the posterior maxilla region, knowledge of the anatomy and variations of the maxillary sinus is fundamental to avoid complications.[7] Although a panoramic radiograph is of considerable help to the dental surgeon to provide information about MTM and the surrounding structures, it may present certain deficiencies in terms of distortion and blurred images[12] because it is a two-dimensional image. On the other hand, no other imaging modality in dentistry has made as great an impact on dental procedures in as short a time as CBCT.[13] Sharan and Madjar[14] compared images from panoramic X-rays and CT scans and found root protrusion into the sinus in first and second molars. However, they reported that the panoramic X-rays show projections of dental roots within the MS that were not confirmed by CT scans, i.e., only 39% of the roots were actually inside the sinus. In the present study, 27.5% of all MTM roots projected into the MS interior were confirmed by CBCT, which ensures a greater degree of confidence in the results found. The periapical area may be reproduced using CBCT scanning, especially when the maxillary posterior root apices are in close contact with the MSF, whether they protrude within the sinus or not.[4]

A number of authors have studied the relationship between the roots of the maxillary molars and the MS. The mean distance between the apices of the maxillary posterior teeth and the floor of the MS was measured from computed tomographic

display data from 12 autopsy specimens and 38 human subjects and demonstrated that the apex of the mesiobuccal root of the maxillary second molar was closest to the sinus.[15] In a CT scan study using dehydrated hemi maxillae, the distance between the root apex of the maxillary teeth and the lower wall of the MS showed a tendency to decrease in the direction of the posterior region, but these authors excluded the third molar.[16] The close proximity established between the MS floor and posterior teeth roots apices (including third molars) was evaluated by using CBCT scanning, and the second molar mesiobuccal root apex was frequently found in close proximity to the sinus floor.[4] Kilic et al.[9] evaluated, in cross-sectional images via CBCT, the deepest point between the MS floor and the tips of the roots of maxillary premolars and the first, second, and third molars. Apexes in close contact (without the root protruding into the sinus) and apexes protruding into the sinus were found in approximately 25.4% and 10.5% of the cases, respectively. The present study evaluated MTM roots exclusively and found contact with the cortical bone of 94 separate and 21 fused roots. The proximity of these anatomic structures should be considered during treatment planning to prevent an iatrogenic procedure and minimize the risk of an infectious disease within the sinus.[4]

Using computed tomography, Ariji et al.[10] presented a classification considered effective for analyzing the relationship between the apexes of maxillary roots and odontogenic infection, according to the visualization of the sinus. The most frequently observed relationship was Type II for the first and second molars on both sides. The sinus was therefore adjacent to the roots between the level of the furcation and the apexes. This result was similar to that of the present study in which the root position most frequently related to the visualization of the sinus was Type II (n = 39). Out of these 39, 16 (41%) were associated with a perforation of cortical bone after third molar extraction. In another analysis, the odds ratio revealed a three times higher risk of MS cortical perforation when the MTM roots were in the Type II category, demonstrating that this position presents a substantially increased risk for an oroantral communication.

The multiplanar CBCT scans obtained from the axial sections of 116 MTMs revealed that the frequency of three-rooted MTMs was maximum (55.2%), followed by one root (31.0%) and two roots (13.8%).[17] Our study evaluated 135 separate and 25 fused roots of 70 MTMs. The separate roots, in the G4 category, showed the highest frequency of perforation when compared with all of the other root groupings

according to the proposed classification level. Furthermore, in the odds ratio, the disto and mesio-vestibular roots presented a 19 and 11 times, respectively, greater chance of MS cortical bone perforation compared with the others in the same classification level.

Oro-antral communication is a known complication after removal of maxillary molars that are in close proximity with the sinus floor.[5] There is no reliable clinical parameter to predict and inform the patient about the possibility of such an occurrence. The probabilities are routinely based on radiological findings and are used to alert the patient about the chances of a sinus mucosa perforation.[5] An oroantral communication can be identified during surgery using the Valsalva maneuver and by careful probing of the extraction socket using a blunt probe.[18] However, if there is no rupture of the sinus mucosa, the cortical bone perforation may not be detected clinically. No other study from our references has estimated and verified the presence of a MS cortical perforation by means of CBCT after extraction of the MTM, and so the frequency of sinus perforation is possibly being underestimated.

The depth of impaction of the MTM is a predictor of the possibility of oro-antral communication, if removal of the tooth becomes necessary.[5] Because of their limitations, panoramic X-rays are not reliable for evaluating sinus proximity and predicting the occurrence of oro-antral perforation.[5] Carvalho et al.[19] estimated that the frequency of intraoperative adverse events during removal of impacted MTMs is correlated with predictive variables. The root apex was related to the MS in more than half of the cases (78.4%), and nonetheless, these authors reported that communication with the MS occurred only in 0.98% of the cases, as confirmed in panoramic X-rays. According Rothamel et al.[18], maxillary tuberosity rupture, root fracture, and partial or complete displacement of the tooth into the MS are common accidents during MTM extraction surgery. In the same study, an occurrence of 13% was found for perforation with oro-antral communication after the extraction of 134 MTMs, identified only clinically by the Valsalva maneuver. The same authors stated that perforation of the MS after MTM extraction is generally not tested clinically or is not properly documented. In this context, the current study found perforation of MS cortical bone in 30% of the 70 MTMs extracted. This result is supported and documented by CBCT images, which ensures its reliability because clinical tests do not always seem to be reliable.

Knowledge of the anatomical relationship between the MS floor and the root apexes is important for planning the preoperative treatment of MTMs, especially in transalveolar approaches that are more susceptible to a perforation of the sinus membrane.[5] According to Kilic et al.[9], considering the MS floor proximity to the apexes of MTM roots, caution should be exercised when performing dental procedures involving these teeth, as Mehra and Murad[20] have stated that 10% to 12% of maxillary sinusitis cases have an odontogenic origin.

MTM surgery requires careful planning with assessment of the risks of complications. Knowledge of the anatomical and topographic aspects specific to their extraction is of undeniable importance given the complications that can arise.

Conclusions

This study showed that the roots of the MTM can be classified by CBCT regarding the proximity to the MS. CBCT technology can be used to assess risks of cortical perforation of the MS in MTM surgery to prevent possible complications such as oro-antral communication and maxillary sinusitis.

Acknowledgments

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Table 1. Association between the classification of the root position according to the visualization of the MS and cortical perforation

	Cortical Perforation			
Classification	**NO n (%)**	**YES n (%)**	**TOTAL n (%)**	***p*-value**
Type I	16 (88.9)	2 (11.1)	18 (100)	
Type II	23 (59)	16 (41)	39 (100)	0.060
Type III	10 (76.9)	3 (23.1)	13 (100)	
Total	49 (70)	21 (30)	70 (100)	

Table 2. Association between perforation and the root position of fused roots in relation to proximity to the MS

	Cortical Perforation			
Classification	**NO n (%)**	**YES n (%)**	**TOTAL n (%)**	***p*-value**
G1	4 (100)	0 (0)	4 (100)	
G2	7 (77.8)	2 (22.2)	9 (100)	0.419
G3	4 (57.1)	3 (42.9)	7 (100)	
G4	3 (60)	2 (40)	5 (100)	
Total	18 (72.0)	7 (28)	25 (100)	

Table 3. Association between the root position of separate roots in relation to their proximity to the MS and cortical perforation

		Cortical Perforation		
Separete root	**Group**	**NO n (%)**	**YES n (%)**	***p*-value**
Mesial	G1	12 (80)	3 (20)	0.086
	G2	12 (70.6)	5 (29.4)	
	G3	6 (75)	2 (25)	
	G4	1(20)	4 (80)	
Distal	G1	6 (85.7)	1 (14.3)	0.008*
	G2	16 (76.2)	5 (23.8)	
	G3	8 (80)	2 (20)	
	G4	1 (14.3)	6 (85.7)	
Palatine	G1	14 (37.7)		0.097
	G2	17 (70.8)		
	G3	0 (0)		
	G4	2 (100)		

* Statistically significant difference.

Table 4. Association between the G4 separate root position and cortical perforation

	Cortical Perforation		
Roots	**NO** **n (%)**	**YES** **n (%)**	***p*-value**
Grouped roots X Disto-Vestibular/G4	48 (73.8) 1 (20)	17 (26.2) 4 (80)	0.002*
Grouped roots X Mesio-Vestibular/G4	48 (76.2) 1 (14.3)	15 (23.8) 6 (85.7)	0.026*
Grouped roots X Palatine/G4	49 (72.1) 0 (0)	19 (27.9) 2 (100)	0.028*

* Statistically significant difference.

Table 5. Estimated risk of cortical perforation of the MS for separate roots in the G4 position in relation to all other roots combined as a group

Root	OR	95% CI
Other roots	1	
Palatine/G4	3.58	2.44 – 5.24
Mesio-Vestibular/G4	11.29	1.18 – 108.24
Disto-Vestibular/G4	19.20	2.14 – 172.41

OR: Odds ratio

CI: Confidence interval

Figure Legends

Figure 1. A. Image of an axial section used for classification of the root in relation to the MS visualization; **B.** Image of the corresponding sagittal section. Red line: region where the MS is first seen.

Figure 2. Images of axial **(A)** and sagittal **(B)**sections for fused root classification in relation to the MS. Red line: top line of the cervical third of the root as a substitute for the level of the furcation.

Figure 3. Axial **(A)** and sagittal **(B)** CBCT sections for root classification in relation to the MS, illustrating a Type I case. Red line: root furcation line. Axial **(C)** and sagittal **(D)** CBCT sections for root classification in relation to the MS, illustrating a Type II case. Red line: line above the apex of the longest root. Axial **(E)** and sagittal **(F)** CBCT section for root classification in relation to the MS, illustrating a Type III case. Red line: line above the root apex.

Figure 4. Coronal section identifying the G1 group **(A)**, the G2 group **(B)**, the G3 group **(C)** and the G4 group **(D)**according to modified Pagin et al.[4] classification.

Figure 5. A. Image of perforated MS cortical bone. **B.** Image of intact MS cortical bone.

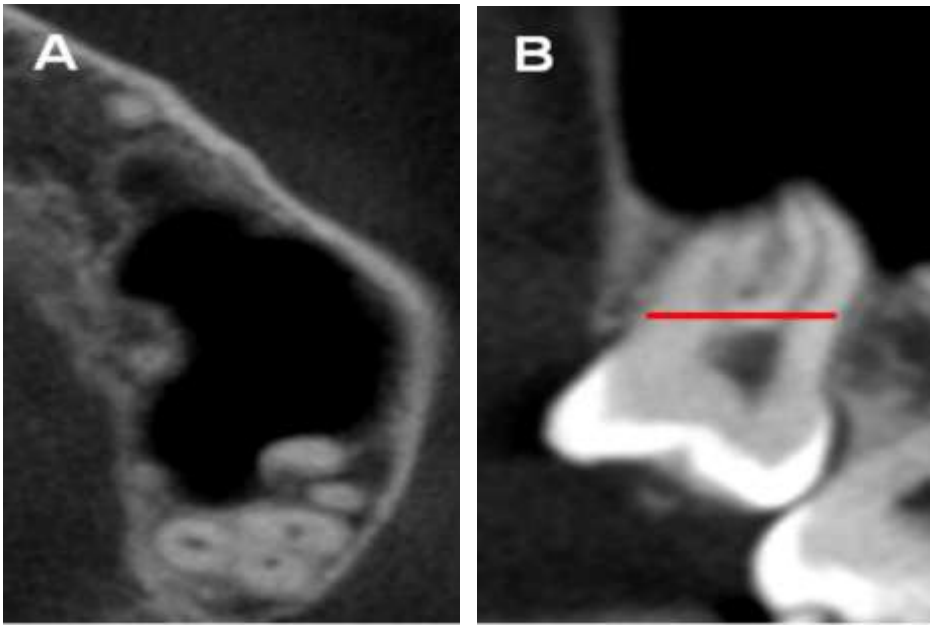


Figure 1. A. Image of an axial section used for classification of the root in relation to the MS visualization; **B.** Image of the corresponding sagittal section. Red line: region where the MS is first seen.

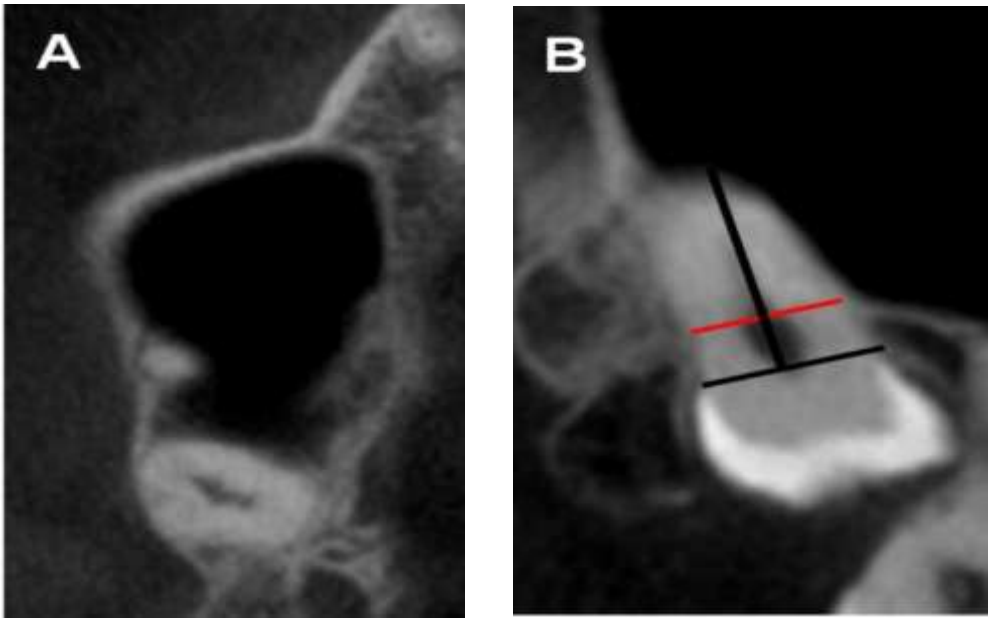
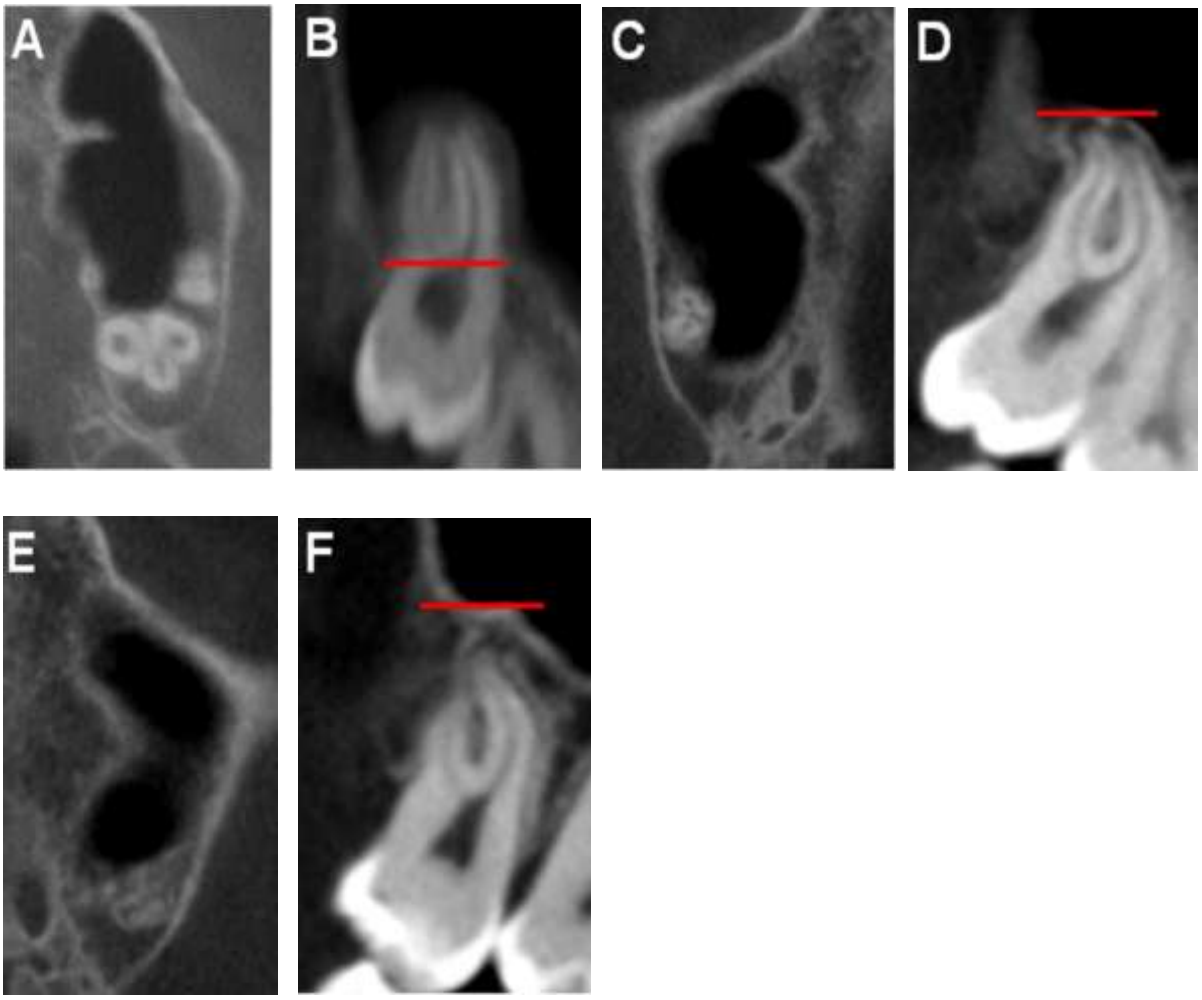


Figure 2. Images of axial **(A)** and sagittal **(B)** sections for fused root classification in relation to the MS. Red line: top line of the cervical third of the root as a substitute for the level of the furcation.



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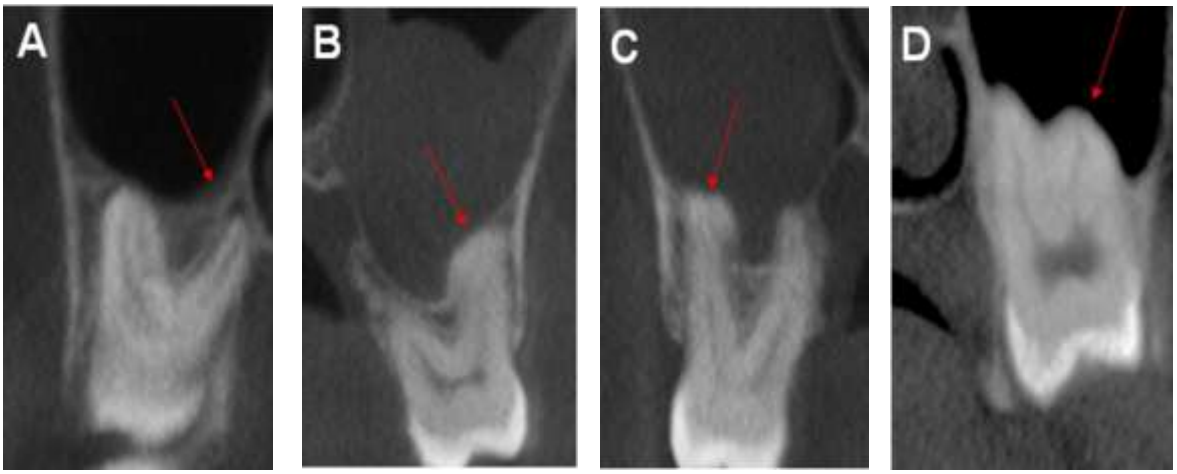

Figure 4. Coronal section identifying the G1 group **(A)**, the G2 group **(B)**, the G3 group **(C)** and the G4 group **(D)**according to modified Pagin et al.[4] classification.

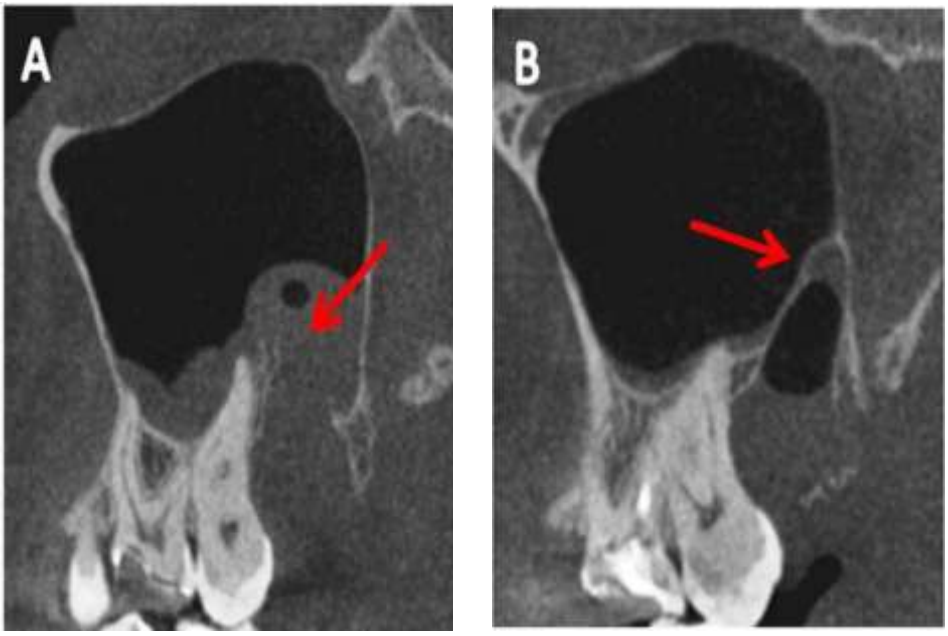

Figure 5. A. Image of perforated MS cortical bone. **B.** Image of intact MS cortical bone.

5 CONSIDERAÇÕES FINAIS

Este estudo demonstrou que as raízes do terceiro molar superior podem ser classificadas, através de TCFC, quanto à proximidade e visualização em relação ao assoalho do seio maxilar. Podemos afirmar que as raízes desses dentes, projetadas ou não, estão associadas ao rompimento da cortical óssea do seio maxilar.

É de fundamental importância usar a tecnologia da TCFC para avaliar riscos, a fim de se prevenir possíveis complicações, tais como a comunicação buco sinusal e a sinusite maxilar na cirurgia do terceiro molar superior.

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ANEXO A – Parecer do Comitê de Ética em Pesquisa

UNIVERSIDADE FEDERAL DE JUIZ DE FORA/MG

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação tomográfica e da qualidade de vida em pacientes submetidos a exodontia de terceiros molares superiores inclusos e semi-inclusos.

Pesquisador: Neuza Maria Souza Picorelli Assis

Área Temática:

Versão: 3

CAAE: 26816714.0.0000.5147

Instituição Proponente: FACULDADE DE ODONTOLOGIA

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 699.347

Data da Relatoria: 24/06/2014

Apresentação do Projeto:

Estudo bem delineado, boa fundamentação, justificativa pertinente e valor científico.

Objetivo da Pesquisa:

Os objetivos estão claros e são passíveis de serem executados.

Avaliação dos Riscos e Benefícios:

Identificação dos riscos e desconfortos possíveis e benefícios esperados estão adequadamente descritos.

Comentários e Considerações sobre a Pesquisa:

O projeto está bem estruturado, delineado e fundamentado, sustenta os objetivos do estudo em sua metodologia de forma clara e objetiva.

Considerações sobre os Termos de apresentação obrigatória:

O projeto está em configuração adequada.

Recomendações:

Diante do exposto e de acordo com as atribuições definidas na Res.CNS 466/12 do CNS e na Norma Operacional Nº 001/2013 - CNS, manifesto pela aprovação do protocolo de pesquisa

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Bairro: SÃO PEDRO **CEP:** 36.036-900
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UNIVERSIDADE FEDERAL DE JUIZ DE FORA/MG

Continuação do Parecer: 699.347

proposto.

Conclusões ou Pendências e Lista de Inadequações:
Possíveis inadequações ou possibilidades de pendência deixam de existir. Diante do exposto, o projeto está aprovado, pois está de acordo com os princípios éticos norteadores da ética em pesquisa estabelecido na Res. 466/12 CNS e na Norma Operacional Nº001/2013 CNS. Data prevista para o término da pesquisa:Setembro de 2014.

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

Considerações Finais a critério do CEP:
Diante do exposto, o Comitê de Ética em Pesquisa CEP/UFJF, de acordo com as atribuições definidas na Res. CNS 466/12 e na Norma Operacional Nº001/2013 CNS, manifesta-se pela APROVAÇÃO do protocolo de pesquisa proposto. Vale lembrar ao pesquisador responsável pelo projeto, o compromisso de envio ao CEP de relatórios parciais e/ou total de sua pesquisa informando o andamento da mesma, comunicando também eventos adversos e eventuais modificações no protocolo.

JUIZ DE FORA, 26 de Junho de 2014

Assinado por:
Paulo Cortes Gago
(Coordenador)

Endereço: JOSE LOURENCO KELMER S/N
Bairro: SAO PEDRO **CEP:** 36.036-900
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ANEXO B – Normas para publicação

JOURNAL OF ORAL AND MAXILLOFACIAL SURGERY
Official Journal of the American Association of Oral and Maxillofacial Surgeons

AUTHOR INFORMATION PACK

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ISSN: 0278-2391

DESCRIPTION

This monthly journal offers comprehensive coverage of new techniques, important developments and innovative ideas in **oral** and **maxillofacial surgery**. Practice-applicable articles help develop the methods used to handle **dentoalveolar surgery**, **facial injuries** and **deformities**, **TMJ disorders**, **oral cancer**, **jaw reconstruction**, **anesthesia** and **analgesia**. The journal also includes specifics on new instruments and diagnostic equipment and modern therapeutic drugs and devices. *Journal of Oral and Maxillofacial Surgery* is recommended for first or priority subscription by the Dental Section of the Medical Library Association.

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Abstract Example (Hypothesis driven patient-oriented research)-
Comparative Effectiveness of Maxillomandibular Advancement and Uvulopalatopharyngoplasty for the Treatment of Moderate to Severe Obstructive Sleep Apnea
Scott B. Boyd, DDS, PhD, Arthur S. Walters, MD, Yanna Song, MS, Lily Wang, PhD

Purpose
To directly compare the clinical effectiveness of maxillomandibular advancement (MMA) and uvulopalatopharyngoplasty (UPPP)—performed alone and in combination—for the treatment of moderate to severe obstructive sleep apnea (OSA).

Patients and Methods
The investigators designed and implemented a retrospective cohort study composed of patients with moderate to severe OSA (baseline AHI >15). The predictor variable was operative treatment and included MMA, UPPP, and UPPP followed by MMA (UPPP/MMA). The primary outcome variable was the apnea-hypopnea index (AHI) measured preoperatively and 3 months to 6 months postoperatively. Other variables were grouped into the following categories: demographic, respiratory, and sleep parameters. Descriptive and bivariate statistics were computed.

Results
The sample was composed of 106 patients grouped as follows: MMA (n = 37), UPPP (n = 34), and UPPP/MMA (n = 35) for treatment of OSA. There were no significant differences between the 3 groups for the study variables at baseline, except for AHI. Surgical treatment resulted in a significant decrease in AHI in each group: MMA (baseline AHI, 56.3 ± 22.6 vs AHI after MMA, 11.4 ± 9.8; *P*< .0001), UPPP/MMA (baseline AHI, 55.7 ± 49.2 vs AHI after UPPP/MMA, 11.6 ± 10.7; *P*< .0001), and UPPP (baseline AHI, 41.8 ± 28.0 vs AHI after UPPP, 30.1 ± 27.5; *P* = .0057). After adjusting for differences in baseline AHI, the estimated mean change in AHI was significantly larger for MMA compared with UPPP (MMA AHI, -40.5 vs UPPP AHI, -19.4; *P* = < .0001). UPPP/MMA was no more effective than MMA (*P* = .684).

Conclusion

The results of this study suggest that MMA should be the surgical treatment option of choice for most patients with moderate to severe OSA who are unable to adequately adhere to CPAP.

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ANEXO C – Comprovante de submissão do artigo

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Name: Karina Lopes Devito Date: 21/09/2016

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❑	❑	❑	❑	❑	❑

I affirm that the foregoing information is complete and truthful, and I agree to notify the AAOMS immediately if there are any changes or additions to my relevant financial relationships. During my participation in this activity, I will wholly support the AAOMS'

commitment to conducting CDE activities with the highest integrity, scientific objectivity, and without bias. I agree that I will not accept any honoraria, additional payments or reimbursements beyond what has been agreed upon to be paid directly by the AAOMS in relation to this educational activity.

Electronic Signature*: 

Date: 21/09/2016

Corresponding author

*Electronic signature required from **corresponding author only**. It is the responsibility of the corresponding author to collect and submit all relevant conflicts of interest (or lack thereof) of all contributing authors at the time of the submission.

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DISCLOSURE OF FINANCIAL RELATIONSHIPS WITHIN 12 MONTHS OF DATE OF THIS FORM

_**X** _ **NO—**Neither I, nor any member of my immediate family, has a financial relationship or interest (currently or within the past 12 months) with any entity producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients.

OR

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	RELEVANT FINANCIAL RELATIONSHIP(S)RELATED TO YOUR CONTENT (CHECK ALL THAT APPLY)				
Commercial Interest(s) (any entity producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients.)	**Research Grant (including funding to an institution for contracted research)**	**Speakers' Bureau**	**Stock/Bonds (excluding Mutual Funds)**	**Consultant**	**Other (Identify)**
NO	**NO**	**NO**	**NO**	**NO**	**NO**
❑	❑	❑	❑	❑	❑

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Name: Priscila Ferreira de Andrade Priscila Ferreira de Andrade

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❑	❑	❑	❑	❑	❑

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❑	❑	❑	❑	❑	❑

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❑	❑	❑	❑	❑	❑

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