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ORAL PATHOLOGIES ASSOCIATED WITH IMPACTED SECOND MOLAR: CONE BEAM COMPUTED TOMOGRAPHY STUDY

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ABSTRACT

This study aimed to evaluate oral pathological processes and/or dental anomalies associated with unerupted permanent second molar in cone beam computed tomography images of adolescents and adults. This is a retrospective cross-sectional study in which unerupted second permanent molars were analyzed using tomographic images obtained from 16 Brazilian patients. Thirteen of whom had second permanent molars with unilateral impaction and 3 bilaterally, totalling 19 tomographic images. The highest prevalence occurred in lower permanent second molars unilaterally on the left side in male individuals with an average age of 20 years. The most common dental anomalies associated with the impacted permanent second molar were eruptions disorders in all adjacent third molars evaluated. Dental anomalies of number were verified in 2 (10.5%) cases of supernumerary teeth and of shape in 14 (73.7%) cases of root dilacerations. No ankylosis process was observed. Among the oral pathologies, 3 (15.8%) were external root resorption in the adjacent first permanent molar and 2 (10.5%) revealed hypodense images with cystic appearance. The position of the impacted second permanent molar was not associated with angulation of the adjacent third molar and oral pathologies ($p > 0.05$).

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INTRODUCTION

Changes in the eruption pattern of the permanent second molar are usually diagnosed by radiographic imaging as a secondary finding during an orthodontic assessment. Genetic and/or local factors can influence the process of tooth eruption. Among the external etiological agents, the angulation of its tooth germ, reduced dental arch space, early eruption of the third molar, ankylosis or the presence of odontogenic cysts/tumors in the eruptive path can be considered potential etiological risk factors for permanent second molar eruption disorders (Selvido, 2022; Kuang *et al.*, 2023; Turley, 2020; Shapira *et al.*, 2011). Kuang *et al.* (2023) show that the association of a cystic lesion with the permanent second molar is the main etiology of the eruption deviation of this tooth, which has an apical to occlusal eruption pattern; therefore, more apical impeding factors are primarily responsible for eruption disorders. The authors warn that the presence of adjacent third molars occupying the space of the permanent second molar is considered a secondary interference in the eruption process. In the literature, the influence of the eruption disorder of the adjacent third molar on the impaction process of the permanent second molar is still controversial. Recent studies show that 90 to 100% of adjacent

third molars are in the space intended for eruption of the second molar, signaling premature root development of the third molar, which could lead to competition for space in the dental arch. Despite this high prevalence, no statistical significance was found between the presence of this tooth and impaction of the second molar (Shapira, 2011 and Cassetta *et al.*, 2014). Studies report a higher occurrence of dental development anomalies in individuals with impacted permanent mandibular second molars, such as root dilaceration, taurodontism, shorter root lengths and invaginations (Shapira, *et al.*, 2011; Cassetta *et al.*, 2014 and Po-Sung, 2012). But is this a cause or an effect of impaction? In any case, it's important to diagnose them because root anomalies in this impacted tooth can interfere with treatment strategies such as repositioning this tooth using orthodontic verticalization mechanics (Turley, 2020 and Po-Sung, 2012). Currently, cone beam computed tomography (CBCT) is playing a leading role in the three-dimensional assessment of factors that prevent tooth eruption and its effects, such as permanent second molars¹. There is little research in the literature on characteristics and potential etiological and risk factors associated with impacted permanent second molars. In this context, this study aimed to three-dimensionally assess oral pathological processes and/or dental

anomalies related to unerupted permanent second molars in CBCT images of adolescents and adults.

MATERIAL AND METHODS

This was a retrospective cross-sectional observational study of tomographic images of unerupted permanent second molars (PM2) obtained from the archives of an oral diagnostic imaging institute from 2018 to 2023. This study was approved by the Research Ethics Committee under No. 38859320.2.0000.0055. A survey was carried out of cone beam computed tomography (CBCT) images of maxillary and mandibular impacted MP2 regions belonging to the radiographic documentation of 16 Brazilian patients, both sexes, between 15 and 30 years of age, without related syndromes and/or congenital anomalies. The overall age of the included patients was 20.0 ± 3.40 years (20.01 ± 4.30 for men, 19.09 ± 1.02 for women). The inclusion criteria were tomographic images of: (1) bilateral ou unilateral PM2; (2) maxillary and mandibular intraosseous PM2; (3) PM2 with root formation in Nolla stage 10⁷; (4) high-quality CBCT. In addition, the parameters for non-inclusion in the sample were the presence of metallic material that generates artifacts in the image (dark zone) in these teeth with the promotion of false readings and orthodontic mechanics related to unerupted permanent second molars. The scans were obtained by volumetric acquisition on a Carestream 9600 cone beam CT scanner with 150 μ m, 120 KV, 80 mA, 8 second exposure, 5x5 field of view. Study without magnification (real size 1:1).

Two experienced radiologists interpreted the image, keeping a distance of approximately 50 cm from the computer screen. Twenty per cent of all the images were assessed again by each professional in order to eliminate memory bias at an interval of three weeks from the initial viewing. For this study, the term impacted was adopted for the tooth element that is retained due to the presence of a radiographically detected mechanical barrier, preventing the tooth from erupting in its estimated time (Bondemark and Tsiopa, 2007). With regard to the impacted PM2 on the alveolar process, the following patient variables were analyzed: age; sex; apical bases (Maxilla/Mandible); laterality (Unilateral/Bilateral); side of dental arches (Right/Left) for unilateral cases. The position of the long axis of the PM2 in relation to the long axis of the PM1 was analyzed as: mesial- when the long axis of the PM2 is in a medial position in relation to the long axis of the PM1; distal- when the long axis of the PM2 is in a distal position in relation to the long axis of the PM1; vertical - when it is parallel in relation to the long axis of the PM1; horizontal - when the long axis of the PM2 is perpendicular to the long axis of the PM1 (Figure 1).

Oral pathologies associated with impacted PM2 were analyzed by the presence of hyperdense/hypodense images involving this unerupted dental unit. External root resorption in adjacent teeth was assessed according to its location: in the apical root contour; in the middle third of the root; in the apical and middle thirds of the root. The dental anomalies related to the impacted PM2 were verified as eruption disorders in other dental units, number and shape anomalies. Among the morphological characteristics, the roots of the PM2 were assessed for dilaceration: mesial; distal; in both roots; without dilaceration or fused. In relation to the adjacent third molar (M3), was analyzed: whether it was unerupted, erupted/semi-erupted or absent; the positioning of its long axis in relation to the long axis of the PM1 (Mesial, distal, vertical and horizontal). Inter-examiner and intra-examiner agreement were assessed using the Kappa coefficient test. The descriptive analysis of the data used the mean, standard deviation (SD), minimum and maximum values and absolute and relative frequencies. Associations between demographic and clinical characteristics and associated anomalies were tested using Fisher's exact test, since all the variables had expected frequencies of less than five. The significance level adopted in the analyses was 5% ($\alpha = 0.05$). The data was tabulated and analyzed using IBM SPSS Statistics for Windows (IBM SPSS, 21.0, 2012, Armonk, NY: IBM Corp.).

RESULTS

All the parameters were assessed and repeated at 3-week intervals on 20% of the sample, randomly selected by two examiners. The results showed satisfactory Kappa (K) coefficient values. Inter-examiner and intra-examiner agreement were perfect (K = 1.00) for all parameters analyzed. Among the CT images of PM2 analyzed from 16 patients, 13 had unilaterally impacted PM2 and 3 bilaterally. Nineteen images of impacted PM2 were evaluated. The sample consisted predominantly of PM2 impacted in the mandible (n=14/ 73.6 %). All bilateral cases occurred in the mandible. Of the 13 unilaterally impacted PM2, 8 (42.1%) were on the left side.

Impacted second molar and oral pathologies: CT images revealed two cases of PM2, maxilla and mandibular, impacted on a hypodense area with a cystic appearance, suggesting anatomopathological analysis (Figure 2).

Impacted second molar and dental anomalies: All M3 adjacent to the PM2 showed eruption disorders.

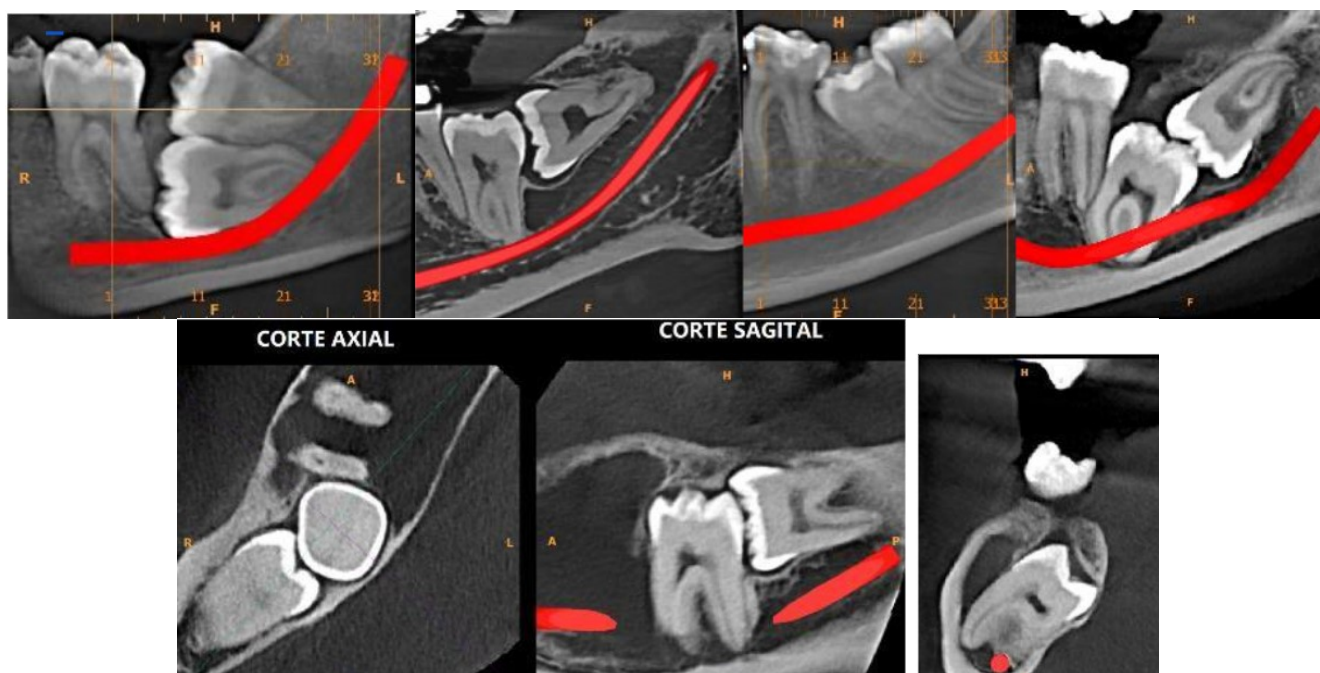


Figure 1.

Table 1. Relationship of impacted permanent second molar with external root resorption of adjacent permanent first molar

IMP2	POSITION	EXTERNAL ROOT RESORPTION AT APM1
47	Horizontal with the crown mesially positioned.	Apical third of the distal root.
17	Distal	Apical and middle third of the distal root.
47	Horizontal with the crown mesially positioned.	Apical and middle third of the distal root.

IPM2- Impacted permanent second molar; APM1- Adjacent permanent first molar.

Table 2. Position of the permanent second molar according to that of the adjacent third molar and associated oral pathology

Variable	Mesial	Distal	Vertical	Horizontal	*p-value
Position of the third molar					
Mesial	0 (0,0%)	1 (33,0%)	0 (0,0%)	2 (66,7%)	
Vertical	1 (33,3%)	0 (0,0%)	2 (66,7%)	0 (0,0%)	0,127
Horizontal	0 (0,0%)	1 (8,3%)	6 (50,0%)	5 (41,7%)	
Associated oral pathology					
External root resorption	0 (0,0%)	1 (33,0%)	0 (0,0%)	2 (66,7%)	
Cystic image	0 (0,0%)	0 (0,0%)	1 (50,0%)	1 (50,0%)	0,565
None	1 (7,1%)	1 (7,1%)	7 (50,0%)	5 (35,7%)	

* Fisher's exact test.

**Figure 2.**

There were 2 cases of impacted PM2 associated with impacted canines with prolonged retention of the predecessor deciduous tooth and an impacted second premolar. About anomalies of number, a fourth molar was observed in the region of the impacted PM2 on the right side of the maxilla. In another case, in the region of the PM2 impacted on the right side of the mandible, there was the presence of a supernumerary intraosseous positioned lingually between the premolars. Root dilacerations were verified by the abnormal curvature in the mesial root of the impacted PM2 (n=11/ 57.9%), distal (n=1/ 5.3%) and both (n=2/ 10.5%). No process of dental ankylosis was observed. In Table 2, the results indicated that there was no association ($p > 0.05$) between the position of the permanent second molar and angulation of the third molar or between the position of the permanent second molar and the presence of oral pathology.

DISCUSSION

This study evaluated 19 tomographic images of unerupted and impacted maxillary and mandibular PM2 from 16 individuals with a mean age of 20 years (SD=3.40) and prevalence of male sex (63.2%). The data analyzed was in agreement with the literature in terms of sex and unilateral occurrence in the left side of mandible^{2,3}. Although Casseta *et al* (2014) verified that among the 23 patients with unilateral impaction, 17 (42.5%) were on the right side and 6 (15%) on the left. Bilateral tooth impaction can be associated with systemic or genetic etiology and have relation with eruption disturbance of other teeth or other dental anomalies¹⁰.

In the present study, 03 individuals with no medical history of related pathologies, syndromes and/or craniofacial anomalies had bilateral impacted 2MP in mandibula and also lower and upper M3 were impacted bilaterally. One of these cases with bilateral impacted lower PM2 was also associated with bilateral palatally impacted maxillary canines with prolonged retention of predecessor deciduous teeth. Local factors may be associated with PM2 eruption disorders that interfere with the eruptive process, such as a shorter retromolar space, odontogenic cysts, ankylosis and root dilacerations (Turley *et al.*, 2020; Casseta *et al.*, 2014; Ghougassian, 2014). In the present study, two impacted PM2 were associated with a hypodense image with a cystic appearance. The development of a cystic lesion was not associated with angulation of the PM2 or positioning of the PM2 in the region of the apical third of the PM1, which characterized a deeper tooth impaction. However, Kuang *et al* (2023) assessed 132 impacted mandibular PM2 using panoramic radiograph and verified that 12 were associated with a radiolucent image suggestive of a cystic lesion and that 91.7% of these patients with pathology of cystic origin were associated with deeper impactions. Supernumerary teeth are generally considered a physical barrier during the eruption of a permanent tooth. There is no reference in the literature that included this kind of etiology to second molars eruption disturbances (Shapira *et al.*, 2011). In this study, there were verified 2 (10.5%) cases of supernumerary teeth in the area of impacted MP2, but they weren't risk factors associated with second molars impaction. Attiello *et al* (2016)¹¹ in a literature review show that disturbances in the positioning of the tooth germ in the eruptive process related with a reduced space in the dental arch can cause compression of the Hertwig's epithelial sheath of this germ and lead to delayed root

development with the formation of torn roots, which will compromise their spontaneous eruption in the alveolar process. In this study, the mesial root (67%) or both (15.8%) of the impacted PM2 had the apical thirds torn in convergence. About the ankylosis process, Turley (2020) observed that vertically impacted lower PM2 may be related to ankylosis. The tomographic images of all the PM2 assessed in this study revealed an intact lamina dura, without ankylosis. Impacted PM2 can interfere with the stability of dental occlusion, compromising masticatory function. In addition, they can cause external root resorption in adjacent teeth⁴. In this study, three impacted PM2 caused root resorption of the adjacent PM1, with the following locations: apical third of the distal root of a 17-years-old patient; apical and middle thirds of the distal root of the 28-years-old patient and in the distal root of the 25-years-old patient. Early diagnosis of this pathology by tomographic investigation is important in order to provide therapeutic intervention to prevent the progression of root resorption. When considering all the research variables, a limitation of the study becomes evident, since in the cases of unilaterally impacted PM2 (n=13/68.4%), the analysis of oral pathologies and dental anomalies were carried out only on the CT images of the PM2 area. However, all those with bilateral impaction also had panoramic cuts of the tomography in their data. Therefore, 68.4% of the sample could have had other dental anomalies and/or oral pathologies in other quadrants. In this context, these percentages are susceptible to modification if a panoramic view were considered.

CONCLUSION

Based on the results presented, it is possible to conclude that:

- Adolescent and young adult patients with impacted permanent second molars had a low prevalence of associated pathology, but overall had a high prevalence of associated dental anomalies;
- The most common dental anomalies associated with the impacted permanent second molar were eruptions disorders in all adjacent third molars evaluated. Dental anomalies of number were verified in 2 (10.5%) cases of supernumerary teeth. Anomalies of shape were observed in 14 (73.7%) cases of root dilacerations. No ankylosis process was revealed in tomographic images.
- Among the oral pathologies, 3 (15.8%) were external root resorption in the adjacent first permanent molar and 2 (10.5%) revealed hypodense images with a cystic appearance.
- The position of the impacted second permanent molar was not associated with the position of the adjacent third molar and oral pathologies ($p > 0.05$).

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