ANALYSIS OF EXTERNAL ROOT RESORPTION OF THE SECOND MOLAR ASSOCIATED WITH AN IMPACTION OF THE THIRD MOLAR BY THE APPLICATION OF CBCT

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ANALIZA EKSTERNE RESORPCIJE KORENOVA DRUGOG MOLARA POVEZANE SA IMPAKCIJOM TREĆEG MOLARA PRIMENOM CBCT-A

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ABSTRACT

External root resorption (ERR) of a tooth represents a process in which irreversible damage occurs to solid dental tissues, more precisely of the cement and dentin. External resorption occurs on the root surface or periodontal ligament, and it is manifested by the loss of cement and/or dentine. The prevalence of ERR of the second molar associated with an impacted third molar, based on retro-alveolar radiography and orthopantomography, ranges from 0.3% to 24.2%. The aim of this research was to analyze ERR of the upper and lower jaw associated with the impacted third molar by the application of the Come Beam Computed Tomography. This study included 96 third molars in the upper and lower jaw of a total of 46 analyzed patients' images. Total prevalence of the second molar ERR associated with the impacted third molar was 8.82%. The second molar ERR was observed in 8 patients (7.84%). Frequency of the second molar ERR in the lower jaw is higher, and it is 8.2%, while in the upper jaw it is only 1% (r = 0.032). Impacted third molars associated with the second molar ERR were most frequently in horizontal (5.1%) and mesioangular (4.1%) position (p = 0.000). The second molar ERR could be avoided by the preventive extraction of mesioangular or horizontal third molars. An adequate decision on the extraction of impacted third molars must be made by the careful assessment of risks and benefits of this surgical intervention. Before the surgical intervention, an adequate care of the second molar, adequate restoration, endodontic treatment or root resection should be done if necessary.

Keywords: *CBCT, external resorption, impacted third molar, second molar*

SAŽETAK

Resorpcija korenova zuba predstavlja proces u kom dolazi do ireverzibinog oštećenja čvrstih zubnih tkiva, tačnije cementa i dentina. Eksterna resorpcija se odvija na površini korena, odnosno periodontalnog ligamenta i manifestuje se gubitkom cementa i / ili dentina. Prevalenca eksterne resopcije korenova drugog molara povezana sa impaktiranim trećim molarom, bazirana na retroalveolarnoj radiografiji i ortopantomografiji je u rasponu od 0,3% do 24,2%. Cilj ovog rada bila je analiza eksternih resorpcija korenova drugih molara gornje i donje vilice povezane sa impakcijom trećeg molara, primenom kompijuterizovane tomografije konusnog zraka (engl. Cone Beam Computer Tomography / CBCT). Ova studija je obuhvatila 96 trećih molara u gornjoj i donjoj vilici od ukupno 46 analiziranih snimaka pacijenata. Ukupna prevalenca eksterne resorpcije korenova drugog molara povezane sa impaktiranim trećim molarom iznosila je 8,82%. Eksterna resorpcija korenova drugog molara zabeležena je kod 8 pacijenata (7,84%). Zabeležena je veća učestalost eksterne resorpcije korenova drugog molara u donjoj vilici i iznosi 8,2%, dok je u gornjoj vilici samo 1% (p =0.032). Impaktirani treći molari povezani sa eksternim resorpcijama korenova drugog molara, najčešće su bili u horizontalnom (5,1%) i mezioangularnom (4,1%) položaju (p=0.000). Eksterne resorpcije korenova drugog molara bi se mogla izbeći preventivnom ekstrakcijom mezioangularno ili horizontalno postavljenih trećih molara. Adekvatna odluka o ekstrakciji impaktiranih trećih molara mora biti doneta pažljivom procenom rizika i prednosti koje donosi ta hirurška intervencija. Pre hirurške intervencije potrebno je adekvatno zbrinjavanje drugog molara, adekvatnom restauracijom, endodontskim tretmanom ili resekcijom korena ukoliko je to neophodno.

Ključne reči: *CBCT, eksterna resorpcija, impaktirani treći molar, drugi molar*

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INTRODUCTION

A root resorption can be a physiological or pathological process, which is characterized by irreversible damage to solid dental tissues like cement and dentin (1). Physiological resorption is a desirable process that occurs in the deciduous dentition, followed by the eruption of permanent substitutes (2). All root resorption of permanent teeth can be classified as pathological resorption (3). Resorption localization in relation to the affected root surface can be an internal and external (4). The internal resorption starts in pulp and it is a progressive destruction of intra-radicular dentine and dentinal tubule along the walls of the middle and apical third of a root canal (5). Cause of the internal resorption lies in infection, traumatic injury or orthodontic therapy (5). The external resorption occurs on the root surface or periodontal ligament and it is manifested by the loss of cement and/or dentin (6). A cause of the external root resorption (ERR) may be local factors (dental impaction, orthodontic treatment, cysts, tumors, periapical inflammatory conditions, luxation or reimplantation of the teeth, periodontal disease and teeth whitening) and systemic diseases (hypoparathyroidism, hyperparathyroidism, Morbus Paget, Tarner syndrome, Gaucher disease) (4).

Third molars that fail to achieve a functional position may have a pathological effect on adjacent tissues, including roots of the second molar. Presence of ERR and dental caries on the second molar's distal surface can be associated with the impacted adjacent third molar (7). This type of resorption often belongs to the group of aseptic resorptions and it occurs at the contact spot of the second and the impacted third molar (8). It is initiated by the pressure of the impacted third molar (9). The second molar ERR pathogenesis is related to the third molar impaction but still remains unknown (10). The opinion is that an injury of the periodontal membrane makes the inflammation which impacts reduced epithelium of an impacted tooth (10). The secretion of inflammatory mediators by reduced tooth epithelium contributes to the activity of osteoclasts and resorption of mineralized tissue (10).

The third molar eruption time is most commonly between the ages of 17 and 21 (7). Making a decision on the prophylactic removal of third molars without symptoms is not easy, for it is necessary to be acquainted with pathological conditions that can be related to third molars (11). The diagnosis of ERR is difficult to establish if the inflammation in the periapical tissue or pulpitis is not observed (7).

An accurate and timely diagnosis of ERR depends on different radiographic methods (12). Inspection and histological analysis are usually not possible (12). Prevalence of the second molar ERR associated with the impacted third molar, based on the retro-alveolar radiography and orthopantomography, ranges from 0.3% to 24.2% (8). Two-dimensional display, unequal magnification, image distortion and superposition affect their low diagnostic value (12, 13). The advantage of the Cone Beam Computerized Tomography (CBCT) is a high spatial resolution and a large number of multiplane images that do not overlap (12). Exposure to X rays is higher in CBCT (45 μSv - 477 μSv), which, in addition to high costs, reduces the routine use for diagnostic purposes (13).

THE AIM OF THE PAPER

The aim of this research was to analyze ERR of the upper and lower jaw associated with the impacted third molar by the application of CBCT.

PATIENTS AND METHODS

In this retrospective study, a total of 186 CBCT scans of patients treated in the Institute of Dentistry at the Faculty of Medical Sciences, the University of Kragujevac were examined. Images of patients who were subjected to CBCT in order to get a diagnosis (endodontics, prosthetics, orthodontics, implantology and oral surgery) were analyzed in the period starting from October 2014 to February 2019. For this study we have an approval of the Faculty of Medical Sciences, the University of Kragujevac and the Ethics committee (01-8190).

The Orthophos XG 3D (Sirona Dental Systems GmbH, Bensheim, Germany) was used to create images with a field size of 8X8cm. The GALAXIS v1.9.4 software (Sirona Dental Systems GmbH, Bensheim, Germany) was used for the three-dimensional reconstruction of images, with a high image definition (100 μm). All recordings were screened in a dimmed room on the Philips LED monitor with a size of 23 inches and a resolution of 1920 x 1080 pixels.

Criteria for an inclusion were recordings of patients older than 18 years, who had at least one-third of the molar and root development of more than two-thirds. Scans showing the existence of carious lesions and fixed prosthodontics on the second or third molar, pathological processes, tumors, bone defects or cysts in the molar region, as well as scans with incomplete third molars, were not analyzed. We included 46 patients' images with a total of 96 third molars in both jaws for the final treatment of results.

ERR can be localized in the apical, middle or cervical third of root (8). In relation to the amount of the lost dental tissue, we have a slight, moderate and severe resorption. The slight resorption is when less than a half of dentin tissue is resorbed. The moderate resorption is when at least a half of dentin tissue is resorbed but not in contact with the dental pulp, and severe resorption is when there is a contact with dental pulp (8).

In order to determine the third molar position and inclinations, we used the Winter and Pell-Gregory classifications (14, 15). Based on the Winter classification, the third molar is mesioangulary positioned when an angle between the longitudinal axis and occlusal surface of the second molar is between 31 and 60 degrees. If that value is less than 31 degrees a tooth is positioned horizontally and vertically if it is greater

than 60 degrees (9). The distoangular position defines a distally oriented longitudinal axis of the third molar in relation to a longitudinal axis of the second molar. Based on the Pell-Gregory classification, vertical position of the third molar can be at the occlusal level (class A), between the occlusal surface and cement-enamel boundary (class B); and below the level of cement-enamel boundary (class C) of the second molar (9).

Statistical processing of the collected data was done by the application of SPSS v20.0 software (SPSS Inc., Chicago, IL, USA). Average values and standard deviations of the measured parameters were calculated and descriptive statistics were made. The accuracy of data was calculated by the Shapiro-Wilk test. For the numerical data that followed a normal distribution, we used the ANOVA test, and for data that did not follow a normal distribution we used the Mann-Whitney test. The chi-square test was used for categorical variables.

RESULTS

This study included 96 third molars in the upper and lower jaw of 46 analyzed patients' images. An average value of patients' years of age was 38.3 (ranging from 19 to 75), 58.7% male, and 41.3% female.

Prevalence of the second molar ERR associated with the impacted third molar was 8.82%. ERR of the second molar was observed in 8 patients (7.84%) (Table 1). A statistical significance was not observed in the presence of ERR of the second molar in relation to the sex and age of patients (r = 0.818). The frequency of ERR of the second molar in the lower jaw is higher, and it is 8.2%, while in the upper jaw it is only 1% (r = 0.032) (Table 2).

There is a statistical significance of the second molar ERR presence in relation to the third molar position. Impacted third molars associated with the second molar ERR were most frequently in the horizontal (5.1%) and mesioangular (4.1%) position (p = 0.000). The second molar ERR frequency is also related to the depth of the third molar impaction. Impacted third molars associated with ERR of the second molar, were mostly in B (4.1%) and C (3.1%) class (r = 0.010).

There was a statistical significance of ERR severity related to the localization of resorption (r = 0.000). Mild resorption is more often present in the cervical and middle third of the root (I class), while the apical third is affected by the severe resorptions (III class). Resorption severity is significantly influenced by the third molar position (r = 0.000) and the depth (r = 0.008) of its impaction (Table 3).

The majority of ERR of the second molar belongs to the I class of resorption with 8.2%, while the III class of resorption was found in only 1% of cases. The II class of second molar ERR was not found at all (Table 4).

Table 1. Prevalence of the external resorption of the second molar roots in relation to sex and age groups

Sex	Prevalence of external resorption				Total	
	Yes		**No**			
Male	4	8,7%	23	50%	27	58,7%
Female	4	8,7%	15	32,6%	19	41,3%
Total	**8**	**17,4%**	**38**	**82,6%**	**46**	**100%**
Age groups						
19-26	3	6,5%	7	15,2%	10	21,7%
27-35	1	2,2%	10	21,7%	11	23,9%
>36	4	8,7%	21	45,7%	25	54,4%
Total	**8**	**17,4%**	**38**	**82,6%**	**46**	**100%**

Table 2. Prevalence of the external resorption of the second molar roots in relation to the location of third molars

External resorption of the second molar Note: analyzed by Fisher exact test							
	Yes		**No**		**Total**		**P value**
Jaw							
Upper	1	1%	46	46,9%	47	48%	**0.032**
Lower	8	8,2%	43	43,8%	51	52%	
Third molar localization							
Upper right third molar	0	0	24	24,5%	24	24,5%	**0.129**
Upper left third molar	1	1%	22	22,4%	23	23,5%	
Lower left third molar	4	4,1%	21	21,4%	25	25,5%	
Lower right third molar	4	4,1%	22	22,4%	26	26,5%	
The Winter classification							
Horizontal	5	5,1%	5	5,1%	10	10,2%	**0,000**
Vertical	0	0	64	65,3	64	65,3%	
Mesioangular	4	4,1%	12	12,2%	16	16,3%	
Distoangular	0	0	8	8,2%	8	8,2%	
The Pel-Gregory classification							
A	2	2%	61	62,2%	63	63,3%	**0,010**
B	4	4,1%	19	19,4%	23	23,5%	
C	3	3,1%	9	9,2%	12	12,2%	

Table 3. Prevalence of the external resorption of the second molar roots in relation to the position of the third molars

Resorption classification Note: analyzed by Fisher exact test							
	No		**I**		**III**		**P value**
Jaw							
Upper	46	46,9%	1	1%	0	0%	**0.043**
Lower	43	43,9%	7	7,1%	1	1%	
Resorption localization							
Cervical third	89	90,8%	5	5,1%	0	0%	**0.000**
Middle third			3	3,1%	0	0%	
Apical third			0	0,0%	1	1%	
The Winter classification							
Horizontal	64	65,3%	0	0,0%	0	0%	**0.000**
Vertical	5	5,1%	4	4,1%	1	1%	
Mesioangular	12	12,2%	4	4,1%	0	0%	
Distoangular	8	8,2%	0	0%	0	0%	
The Pel-Gregory classification							
A	61	62,2%	2	2%	0	0%	**0.008**
B	19	19,4%	4	4,1%	0	0%	
C	9	9,2%	2	2%	1	1%	

Table 4. Prevalence of localization and a class of the external root resorption of the second molar in relation to the localization and position of third molars

Third molar localization		
Upper right third molar	24	24,5%
Upper left third molar	23	23,5%
Lower left third molar	25	25,5%
Lower right third molar	26	26,5%
Resorption classification		
Without	89	90,8%
I	8	8,2%
III	1	1%
Resorption localization		
Without	89	90,8%
Cervical third	5	5,1%
Middle third	3	3,1%
Apical third	1	1%
The Winter classification		
Vertical	10	10,2%
Horizontal	64	65,3%
Mesioangular	16	16,3%
Distoangular	8	8,2%
The Pel-Gregory classification		
A	63	63,3%
B	23	23,5%
C	12	12,2%

DISCUSSION

The second molar ERR associated with the impacted third molar is not a rare occurrence and it is often overlooked due to a lack of clinical symptoms. It is also considered to be one of the complications of impacted third molars (10). A cause of the third molar impaction is not exactly defined. One theory advocates an evolutionary reduction in the jaw size caused by lesser bone growth stimulation which is associated with a modern diet that has an inadequate chewing effect (16, 17).

In our study, ERR of the second molar associated with the impacted third molar was present in 7.84% of the cases, which is 8.82% of the examined teeth. Previous studies have shown that the prevalence of the second molar ERR associated with the impacted third molar ranges from 0.3-24.2%, by the application of the retro-alveolar radiography and orthopantomography (8). However, the prevalence of 20.2-54.9% ERR of the second molar was found by the application of CBCT (8). The Oenning et al study states that the prevalence of the ERR of the second molar is associated with the third molar impaction even higher (49.43%) by the application of CBCT versus standard radiographic methods (9). In the oral and maxillofacial surgery, the orthopantomographic scan is commonly used for the examination of the third molar position and its relation with the mandibular canal (18). Disadvantages of two-dimensional radiography are a poor resolution, image distortion, poor magnification and overlapping of anatomical structures. CBCT provides better diagnostic information in the sagittal, axial and coronary dimensions without overlapping of anatomical structures and pathological conditions, especially in the earlier stages of the formation (19, 20, 21). Alqerban and associates in their study suggested better detection of the resorption of the lateral incisor roots using the three-dimensional radiographic method (19).

Tassoke in his study showed a higher rate of ERR of the second molar in the lower jaw, which was also the case in our study (7). That study showed that there was 4 times greater risk for ERR in mandibular than in maxillary molars (7). This distribution is explained by the third molars eruption process in the lower jaw (7). There are many factors with an impact on that process like the limited skeletal and vertical condylar growth, a lack of space for the eruption due to an inadequate size of the crown, delayed eruption and the impossibility of adequate positioning of the third molar embryo (10,21).

By the application of the Winter classification, our study showed that the mesioangular and horizontal position of the impacted third molar has a greater risk for the second molar ERR. This result is consistent with results of previous studies (7,10, 12, 22 – 24). The least frequent third molar position was horizontal. Oenning and associates showed that there is no statistical significance in difference of the second molar external resorption in comparison with the mesioangular and horizontal third molar position. This result shows that a larger contact surface between horizontally impacted third molar crown and the second molar root does not represent a significant risk factor for external resorption (9). Our study also showed that there is no statistically significant difference in the second molar ERR formation, in relation to the mesioangular and horizontal third molar position.

Wang et al. showed the highest presence of the second molar ERR, based on the Pell-Gregory classification, in the class A (29.8% of cases), then the class C (24.5%), while the class B was the least represented (16.1% of cases) (12). Our study showed that the second molar ERR was classified mostly in the class B 4,1%, the class C 3% and the class A in 2% of cases.

Studies have shown that ERR is mostly localized in the cervical third of the second molar when localization of the third molar belongs to classes A and B (9). In our study, second molar ERR is most commonly localized in the cervical third (5.1%). The impacted third molars most often cause ERR in the apical third (25). In our study, only the apically localized resorption was in the class C.

Some studies showed a higher prevalence of the second molar ERR associated with the impacted third molar in male subjects due to the jaw or tooth size. Researchers explain this fact by the influence of sex hormones (26, 27). However, there are studies that show that the gender is not a risk factor for the second molar ERRs, which coincides with our results (7, 9). Wang et al. have shown in their research that the existence of the impacted third molar in the age group over 35 years is a risk factor for the second molar (12), while Oenning et al. have shown that this age limit is 24 years (9). This result of Wang et al. is possible due to the expected progression of the ERR second molar due to the prolonged retention of the impacted third molar (23).

There is no evidence to justify the prophylactic extraction of third molars unless there is an adequate clinical symptomatology. Although common complications of the impacted third molars are known, the scientific debate is raised whether the occurrence of the first clinical symptoms should be awaited for the preventive extraction. A lack of clinical confirmation of diagnosis found by CBCT is a limiting factor in our and other studies. Further research in this area is needed to obtain more precise results.

CONCLUSION

The second molar ERR could be avoided by a preventive extraction of the mesioangular or horizontally placed third molars (16). An adequate decision for the extraction of impacted third molars must be made by careful assessment having in mind risks and benefits of this surgical intervention. Prior surgical intervention, an adequate care of the second molar, the restoration, the endodontic treatment or the root resection should be done if necessary (28 – 30).

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