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Preoperative evaluation of third molar root characteristics: Correlation between clinical and radiographic findings

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Abstract

Objective: In this study, periapical and panoramic radiographic tests were compared to the clinical examination (after extraction, gold standard) to verify their accuracy in identifying number of roots, root morphology, and presence of root dilaceration in impacted third molars.

Methods: In total, 98 third molars were extracted (50 maxillary, 48 mandibular). Three dental surgeons and one radiologist were calibrated to analyze the root characteristics before (radiography) and after extraction. Agreement between clinical and radiographic findings was analyzed with weighted kappa (κ) statistics. Correlation between radiographic and clinical data was assessed using Spearman correlation test. A 5% significance level was set for all analyses.

Results: Upper teeth with single/fused roots and lower teeth with two roots were predominant. Higher agreement and correlation for number of roots and root morphology was observed for periapical (κ=0.258–0.612; R^2=0.463–0.612; P<0.001) compared with panoramic exam (κ=0.164–0.365; R^2=0.175–0.417; P<0.01), and for lower compared with upper teeth. For lower teeth, convergent/parallel roots were predominant in the clinical analysis, while divergent roots were predominant in the imaging tests. For root dilaceration, poor agreement (κ=0.199–0.273) and low correlation (R^2=0.185–0.306) was observed for either radiographic examinations.

Conclusion: The accuracy of radiographic examinations in identifying the root characteristics of impacted third molars was generally low. Compared with the panoramic test, periapical radiography had better agreement and higher correlation with the clinical findings for all root features.

Key words: Dental, radiography; Molar, tyhird; Impacted tooth; surgery, oral

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Avaliação pré-operatória das características radiculares de terceiros molares: Correlação entre características clínicas e radiográficas

Resumo

Objetivo: Neste estudo, radiografias panorâmicas e periapicais foram comparadas ao exame clínico (após extração, padrão ouro) para avaliar sua precisão em identificar o número de raízes, a morfologia radicular e a presença de dilaceração em terceiros molares impactados.

Métodos: No total, 98 terceiros molares foram extraídos (50 superiores e 48 inferiores). Três cirurgiões e um radiologista foram calibrados para analisar as características radiculares antes (radiografia) e após as extrações. A concordância entre as características clínicas e radiográficas foi analisada pelo teste de kappa ponderado (κ). Já a correlação dados radiográficos e clínicos foi avaliada usando o teste de correlação de Spearman. Um nível de significância de 5% foi utilizado nas análises.

Resultados: Dentes superiores com uma raiz/raízes fusionadas, e inferiores com duas raízes predominaram na amostra. Concordância e correlação altas para número de raízes e morfologia radicular foi observada para radiografia periapical (κ=0.258–0.612; R^2=0.463–0.612; P<0.001) comparada com a panorâmica (κ=0.164–0.365; R^2=0.175–0.417; P<0.01), e para dentes inferiores comparados aos superiores. Para dentes inferiores, raízes convergentes/paralelas foram predominantes na avaliação clínica, enquanto raízes divergentes foram predominantes nos exames por imagem. Para dilaceração, foi observada pobre concordância (κ=0.199–0.273) e baixa correlação (R^2=0.185–0.306) para qualquer um dos exames radiográficos.

Conclusão: A precisão dos exames radiográficos em identificar as características radiculares de terceiros molares impactados foi geralmente baixa. Comparada ao exame panorâmico, a radiografia periapical teve melhor concordância e maior correlação com os achados clínicos para todas as características radiculares.

Palavras-chave: Radiografia, dentária; Molar, terceiro; Dentes impactados; Cirurgia, oral

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Introduction

Third molars are the teeth that most often fail to erupt [1]. Lack of retromolar space is one of the main causes for this outcome, but race, facial growth, and size of jaws and teeth are crucial factors for the state of impaction [2,3]. Adequate surgical planning is essential for successful treatment of impacted third molars and prevention of accidents and complications [4,5]. The preoperative evaluation might influence the choice of surgical technique and minimize potential problems during surgery, taking into account characteristics such as rhizogenesis, root characteristics, board thickness, and position of the crown [6].

Despite the advances obtained with computed tomography, panoramic radiography (Pan-R) is still the imaging analysis of choice for the diagnosis and treatment planning for extraction of impacted third molars. Pan-R provides a broad view of the maxillofacial area [7]; however, it has shortcomings such as image magnification, potential to present, and poor image detail. Intra-oral X-ray imaging examinations, including periapical radiography (Per-R), provide better detail and fewer distortions than Pan-R. Per-R, in turn, does not always provide an optimal view of impacted third molars, depending on the teeth position.

The literature presents contrasting findings regarding the correlation between clinical findings and findings observed in Per-R and Pan-R. Bell et al. [8] found that Pan-R had low fidelity in the assessment of anatomy and shapes of the structures like root fusion, apical curvature and number of roots. Similarly, Rios-Santos et al. [9] reported that dental apices were better observed in Per-R compared with digital Pan-R, except for the second and third molars, which were better visualized in Pan-R examinations.

The agreement between different imaging tests is important when the preoperative evaluation of third molars involves more than one radiographic examination. Also, the accuracy of radiographs in properly showing the actual root characteristics is crucial [10]. In this study, Per-R and Pan-R imaging tests were compared to the clinical examination to verify their accuracy in identifying the number of roots, root morphology, and presence of root dilaceration in maxillary and mandibular impacted third molars indicated for extraction. The hypothesis tested was that Per-R would have better agreement and higher correlation with the clinical findings than Pan-R.

Methods

The study was approved by the Research Ethics Committee of the School of Dentistry, Federal University of Pelotas, Brazil (protocol 118/2009). The sample consisted of 51 patients (14 men, 37 women, mean age 24 years), who had at least one third molar indicated for extraction, and who signed an informed consent form to participate in the study. Teeth with incomplete root formation or dental anomalies and teeth that needed to be sectioned or fractured during extraction were excluded from the study. Patients were informed about the procedures to be performed; those who agreed to participate in the study signed a consent form. In total, 98 third molars were extracted (50 maxillary, 48 mandibular). Three dental surgeons and one radiologist were calibrated to analyze the studied root characteristics. Calibration was carried out by assessment of extracted third molars obtained from the institution's tooth bank, resulting in a kappa (κ) inter-examiner agreement value ≥ 0.76.

In order to verify the exclusion criteria, a Pan-R was initially obtained for all patients (Rotograph Plus; Villa Sistemi Medical Spa – Buccinasco, Milano, Italy) using 60 to 85 kV, 10 mA, and 14 to 17s exposure time, with a standard magnification of 1.2. Extraoral T-MAT films 12.7×30cm in size were used (Kodak – Rochester, NY, USA). A Per-R was then obtained for each third molar with indication for extraction using the parallelism technique. Per-R examinations were performed using 70 kV, 7 to 10 mA, 1mm total aluminum equivalent filtration, and 0.4 to 0.6s exposure time (Timex 70C; Gnatus – Ribeirão Preto, SP, Brazil). E-speed films (Kodak) 3×4cm in size were used. All radiographs were processed by the time-temperature method in a dark room. A radiology specialist carried out the radiographic analyses in a room shielded from ambient light, using a view box and a magnifying glass.

The surgical technique for each case was selected according to the preoperative planning and performed at an outpatient basis (undergraduate clinics), using local anesthesia. Drugs were prescribed when pain, swelling and/or infection were present. At the end of the surgery, the removed teeth were cleaned from bone and periodontal debris and the clinical examination was performed by the calibrated surgeons by means of visual inspection, without knowledge of the radiographic findings. Clinical data were considered the "gold standard", as imaging analyses are complementary to the clinical examination.

The root characteristics investigated in both radiographic imaging tests as well in the clinical analysis of each extracted third molar were: number of roots (1, 2, 3, or 4), root morphology (single or fused, parallel, convergent, or divergent), and root dilaceration (present or absent). Dilaceration was considered not applicable for convergent roots. Agreement between clinical findings and findings from Per-R or Pan-R examinations was analyzed with weighted kappa statistics (κ-values reported). Correlation between radiographic and clinical data was assessed using non-parametric Spearman correlation analysis (R^2 and *P*-values reported). A 5% significance level was set for all analyses.

Results

Results for number of roots are shown in Table 1. A predominance of upper teeth with single roots and lower teeth with two roots was observed in all examinations. It was not possible to detect teeth with four roots in any of the imaging tests, although 8 maxillary teeth with four roots were observed clinically. Moderate to low agreement

Table 1. Frequency distribution (%) of number of roots

	Clinical	Periapical	Panoramic
Maxillary third molars (n=50)			
One	48	74	64
Two	8	8	6
Three	36	18	30
Four	8	–	–
	κ-value	0.337	0.255
	R^2; P-value	0.543; <0.001	0.417; <0.01
Mandibular third molars (n=48)			
One	27.1	29.2	20.8
Two	62.5	68.7	77.1
Three	10.4	2.1	2.1
Four	–	–	–
	κ-value	0.574	0.365
	R^2; P-value	0.612; <0.001	0.392; <0.01

Table 2. Frequency distribution (%) of root morphology

	Clinical	Periapical	Panoramic
Maxillary third molars (n=50)			
Single or fused	48	74	64
Parallel	20	4	12
Convergent	–	–	–
Divergent	32	22	24
	κ-value	0.258	0.164
	R^2; P-value	0.463; <0.001	0.381; <0.01
Mandibular third molars (n=48)			
Single or fused	27.1	29.2	20.8
Parallel	33.3	16.7	25.0
Convergent	35.4	16.7	14,6
Divergent	4.2	37.4	39.6
	κ-value	0.420	0.316
	R^2; P-value	0.507; <0.001	0.175; 0.23

Table 3. Frequency distribution (%) of root dilaceration

	Clinical	Periapical	Panoramic
Maxillary third molars (n=50)			
Present	47	61	59
Absent	53	39	41
	κ-value	0.235	0.199
	R^2; P-value	0.245; 0.09	0.199; 0.17
Mandibular third molars (n=48)			
Present	32.3	46.9	68.3
Absent	32.3	36.4	17.1
Not applicable	35.4	16.7	14.6
	κ-value	0.273	0.262
	R^2; P-value	0.306; 0.03	0.185; 0.21

between clinical and radiographic findings was found, but higher κ-values were observed for Per-R compared with Pan-Rand for lower teeth compared with upper teeth. Correlation analysis was significant for both imaging tests, with higher correlation between clinical and Per-R findings.

The Table 2 shows the results for root morphology. For maxillary teeth, there was a predominance of single or fused roots in all examinations. For mandibular teeth, while convergent or parallel roots were predominant in the clinical analysis, both radiographic examinations indicated a predominance of divergent roots. Agreement between clinical and radiographic findings was generally poor, and again, the κ-values were higher for Per-R and lower teeth compared with Pan-R and upper teeth. With the exception of Pan-R evaluated in lower teeth, the correlation analysis was significant for all conditions. Per-R data showed a higher correlation with the clinical examination compared with Pan-R data.

For root dilaceration analysis (Table 3), agreement between the clinical and radiographic examinations was very poor for either dental arches or radiographic imaging tests. Correlation between clinical and radiographic aspects was not significant for any of the radiographic examinations, except for Per-R tested in lower teeth.

Discussion

The preoperative planning for the extraction of unerupted teeth aids the surgeon in determining the complexity of the intervention. Imaging tests are helpful diagnostic tools. Pan-R is generally acknowledged as the examination of choice for oral and maxillofacial surgery due to its low cost, ease of image acquisition, and because it allows observation of a large area of the jaws. However, it is known that the position and morphology of impacted third molars are often different from what is shown by imaging tests. Thus, research efforts have been directed to analyze distortions that occur in radiographic tests with respect to the root characteristics of impacted teeth.

Results of the present study provide evidence that the agreement between clinical and radiographic findings from both Per-R and Pan-R was generally low for third molars' root features. Bell et al. [8] have reported low accuracy for radiographs compared with clinical conditions regarding the position and morphology of impacted teeth. The present results also indicate higher accuracy for Per-R tests compared with Pan-R; therefore, the hypothesis tested is accepted. This finding indicates that Per-R provides better image detail, which might be explained by the greater proximity of the X-ray films with the teeth, generating images with dimensions more akin to the actual structures. Comparing the dental arches, the agreement and correlation between imaging and clinical examinations was better for mandibular teeth. This is likely a result of the greater number of bone structures that overlap the maxillary posterior area during X-ray exposure, affecting the radiographic observations.

As reported by a previous study [11], the presence of single or fused roots in third molars is associated with a relatively favorable surgical scenario for extraction. Also, it is known that the risk of root fracture during extraction increases with the increase in the number of roots. Based on the results of the present study, which showed an overall low to moderate accuracy for Per-R and Pan-R examinations in detecting the actual number of roots, care should be taken when some difficulty occurs during the extraction of third molars, as the tooth could have more roots than originally expected. In addition, clinicians should be aware of the possibility of teeth with root morphology different than that shown in the radiographic test [12].

The overall agreement between clinical and radiographic data for root morphology was poor. For upper teeth, the radiographic and clinical analysis showed the same predominant morphology, whereas for lower teeth the predominant radiographic morphology was less complex for an extraction than was observed clinically. This finding highlights that clinicians should be careful during any extraction, possibly having to make use of more complex techniques than originally planned. In addition, the predominance of third molars with one or two fused or convergent roots in our sample might be related to the fact that the teeth were extracted in an undergraduate clinical setting.

In a study linking the radiographic interpretation with apical root fractures of teeth extracted by dental students, it was observed that the operator generally underestimates the possibility of fracture during the preoperative planning [12]. The present results show that both radiographic tests were somewhat inaccurate in indicating the presence of apical dilacerations. Another possibility to assist the surgical planning is the use of CT cone-beam scans that would help with greater accuracy the observation of root features [13]. However, the access to CT imaging depends on several factors, especially in developing countries. It is noteworthy that, in Brazil, a large number of people have access to dental health services through public networks; however, despite the existence of public centers of dental specialties, access to CT cone-beam scans are not yet a reality in the public health system. The development of comparative studies using the CT cone-beam scans for the diagnosis and planning for removal of impacted teeth, combined with the results of the present study, might provide further evidence on the use of usual radiographic examinations.

Conclusion

The accuracy of periapical and panoramic radiographic examinations in identifying the number of roots, root morphology and root dilaceration of impacted third molars was generally low. Compared with the panoramic test, periapical radiography had better agreement and higher correlation with the clinical findings for all root features.

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