UNIVERSIDADE FEDERAL DE JUIZ DE FORA
CAMPUS GOVERNADOR VALADARES
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS APLICADAS À SAÚDE

Tauana Rezende Lopes Macário Ferreira

Os tamanhos do FOV e do *voxel* influenciam na avaliação do istmo de molares inferiores? Um estudo em TCFC

Governador Valadares
2022

Tauana Rezende Lopes Macário Ferreira

Os tamanhos do FOV e do *voxel* influenciam na avaliação do istmo de molares inferiores? Um estudo em TCFC

Dissertação apresentada ao Programa de Pós-Graduação em Ciências Aplicadas à Saúde, da Universidade Federal de Juiz de Fora, Campus Governador Valadares, como requisito parcial à obtenção do título de Mestre em Ciências Aplicadas à Saúde, área de concentração Biociências.

Orientador: Prof. Dr. Rafael Binato Junqueira

Governador Valadares

2022

Tauana Rezende Lopes Macário Ferreira

Os tamanhos do FOV e do voxel influenciam na avaliação do istmo de molares inferiores? Um estudo em TCFC

Dissertação apresentada ao Programa de Pós-graduação em Ciências Aplicadas à Saúde da Universidade Federal de Juiz de Fora como requisito parcial à obtenção do título de Mestre em Ciências Aplicadas à Saúde. Área de concentração: Biociências

Aprovada em 28 de dezembro de 2022.

BANCA EXAMINADORA

Prof. Dr. Rafael Binato Junqueira - Orientador

Universidade Federal de Juiz de Fora

Prof. Dr. Cleidiel Aparecido Araujo Lemos

Universidade Federal de Juiz de Fora

Profª. Drª. Rafaela Andrade de Vasconcelos

Universidade Federal de Alagoas

Juiz de Fora, 12/12/2022.

Documento assinado eletronicamente por **Rafael Binato Junqueira**, **Coordenador(a)**, em 28/12/2022, às 11:11, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Cleidiel Aparecido Araujo Lemos**, **Servidor(a)**, em 28/12/2022, às 11:19, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **RAFAELA ANDRADE DE VASCONCELOS**, **Usuário Externo**, em 28/12/2022, às 11:27, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

A autenticidade deste documento pode ser conferida no Portal do SEI-Ufjf (www2.ufjf.br/SEI) através do ícone Conferência de Documentos, informando o código verificador **1074360** e o código CRC **E7F13283**.

AGRADECIMENTOS

Agradeço, em primeiro lugar, a Deus, por me permitir ultrapassar todos os obstáculos encontrados ao longo dessa jornada, por ter me auxiliado em todas às vezes que pensei em desistir.

Ao meu marido, que foi meu suporte nesses dois anos, minha companhia, que ouviu minhas reclamações, que me deu força e cuidou de mim. Agradeço aos meu pais, que sempre incentivaram minha busca pela educação e conhecimento, que sempre torceram por mim e se preocuparam em me ver no melhor caminho.

Aos meus professores, que me ofertaram tanto conhecimento e aprendizado, que se esforçaram para fazer seu melhor, mesmo dando aula em um formato, até então, novo para todos. Ao meu professor Rafael Binato Junqueira, cuja orientação foi fundamental para que eu chegasse aqui, sem sua direção e apoio eu talvez teria desistido em uma das várias vezes que esse pensamento me ocorreu. Obrigada pela presença, disponibilidade e paciência de sempre. Sempre mesmo, já são 6 anos desde a graduação.

Agradeço os meus colegas mestrandos, pelos momentos compartilhados nos grupos, nas reuniões pelo Meet®, pelo companheirismo e por tornaram essa caminhada mais leve, mais prazerosa.

À UFJF-GV meus sinceros agradecimentos. Instituição que faz parte da minha história. Mesmo com tantos desafios, desde sua implementação até aos dias atuais, vem formando e realizando o sonho de tantas pessoas. Tenho um carinho especial por tudo que aconteceu nesses anos de história compartilhada. Agradeço também a CAPES, pelo apoio dado durante a realização desse mestrado.

RESUMO

Este estudo analisou, por meio de exames de tomografia computadorizada de feixe cônico (TCFC), se o tamanho do campo de visão (FOV) e do *voxel* influenciam na avaliação de istmos em molares inferiores. Quarenta molares inferiores humanos foram submetidos à micro tomografia computadorizada para obtenção do padrão-ouro. Em seguida, foram tomografados (ProMax® 3D Max) de acordo com sete protocolos de aquisição, variando-se os tamanhos de FOV (10 x 5,5 cm e 5 x 5,5 cm) e *voxel* (0,400 mm, 0,200 mm, 0,100 mm, e 0,075 mm). Três avaliadores classificaram a presença e o tipo de istmo, com base em uma escala de cinco pontos. Para comparação da frequência da detecção de istmo em cada protocolo com o padrão-ouro, foi realizado o teste qui-quadrado. Foram calculados os valores de sensibilidade, especificidade e acurácia para cada protocolo de aquisição. A concordância intra e interexaminador foi verificada através do teste Kappa e variou de substancial a quase perfeita. Verificou-se que a presença de istmos foi subestimada, principalmente quando se utilizou *voxel* de 0,400 mm, independentemente do FOV utilizado. O protocolo com FOV 10 x 5,5 cm e *voxel* 0,200 mm apresentou os maiores valores de sensibilidade e acurácia e os menores valores de especificidade. Ao se compararem todos os valores de acurácia, o protocolo 2 (maior FOV) foi superior aos protocolos 4, 5 e 7. Concluiu-se que, independentemente do FOV, o valor do voxel não influenciou na avaliação de istmos em molares inferiores. A escolha do protocolo mais adequado dependerá das particularidades de cada situação clínica.

Palavras-chave: Anatomia radicular; Diagnóstico; Endodontia; Tomografia computadorizada de feixe cônico; *Voxel*; FOV; Istmo.

ABSTRACT

Introduction: This study analyzed, through cone-beam computed tomography (CBCT) scans, whether the size of the field of view (FOV) and voxel influence the evaluation of isthmuses in mandibular molars. **Methods:** Forty human mandibular molars were submitted to microcomputed tomography to obtain the gold standard. Then, they were scanned (ProMax® 3D Max) using seven acquisition protocols, varying in FOV size (10 x 5.5 cm and 5 x 5.5 cm) and voxel (0.400 mm, 0.200 mm, 0.100 mm and 0.075 mm). Two examiners classified the presence and type of isthmus on a five-point scale. To compare the frequency of isthmus detection in each protocol with the gold standard, the chi-square test was conducted. Sensitivity, specificity and accuracy values were calculated for each protocol. **Results:** Intra- and inter-examiner agreement was verified using the weighted Kappa test and ranged from substantial to almost perfect. The presence of isthmuses was underestimated, especially with a 0.400-mm voxel, regardless of the FOV used. The protocol with 10 x 5.5-cm FOV and 0.200-mm voxel presented the greatest sensitivity and accuracy and the lowest specificity values. Upon comparing all accuracy values, protocol 2 (larger FOV) was better than protocols 4, 5 and 7. **Conclusion:** Regardless of FOV, the voxel size did not influence the evaluation of isthmuses in mandibular molars. The choice of the most appropriate protocol will depend on each clinical situation' particularities.

Keywords: Root anatomy; Diagnosis; Endodontics; Cone-beam computed tomography; Voxel; FOV; Isthmus.

SUMÁRIO

1 INTRODUÇÃO

O conhecimento da anatomia do sistema de canais radiculares e suas possíveis variações contribui para o enfrentamento dos desafios associados ao tratamento endodôntico (1). Diversos elementos podem integrar a complexidade anatômica desse sistema, como canais secundários, laterais e istmos (2). O istmo é definido como uma comunicação estreita, em forma de fita, entre dois canais radiculares, que contém tecido pulpar, também conhecido como corredor ou anastomose transversa (3). É uma estrutura particularmente desafiadora para os Endodontistas, uma vez que pode constituir verdadeiros nichos para a proliferação de micro-organismos, contribuindo para o insucesso do tratamento (3).

A incidência de istmo nos molares tem sido investigada na literatura (4, 5, 6, 7). Quando avaliada por Estrela et al (4), em uma população de 618 pacientes, pelo exame de tomografia computadorizada de feixe cônico (TCFC) sua frequência foi de 87.9% nos primeiros e de 66.3% nos segundos molares inferiores. Já Tahmasbi et al (5), encontraram uma frequência de 69.6% de istmos em raízes mesiais de primeiros molares. Outros estudos encontraram prevalência variando de 55.5% a 97.2% (6, 7).

Como a estrutura do istmo se assemelha a uma rede fina, sua presença pode dificultar a realização de um preparo químico-mecânico eficaz (2,3), prejudicando a redução da infecção microbiana no interior do sistema de canais radiculares (8). Os instrumentos utilizados atuam majoritariamente no canal principal, enquanto nos istmos a limpeza e desinfecção dependem principalmente dos efeitos químicos dos irrigantes e medicamentos (2).

Os exames por imagem são essenciais em todas as etapas do tratamento endodôntico, seja para avaliação inicial da anatomia radicular, ao final do tratamento para verificar a qualidade da obturação, ou ainda no controle pós-operatório. A radiografia periapical constitui a primeira escolha, por se tratar de um exame mais barato, mais acessível e com menor dose de radiação, quando comparada à TCFC (9). Porém, diante de casos complexos, como os istmos, a TCFC se torna a melhor alternativa (10), pois viabiliza um diagnóstico mais preciso, ao eliminar as sobreposições e permitir a visualização tridimensional das estruturas nos diferentes planos de orientação (11).

Durante a aquisição de imagens de TCFC, a utilização de diferentes parâmetros de aquisição pode auxiliar no diagnóstico de condições endodônticas (12,13,14). Estudos prévios variaram o tamanho do *voxel* e do campo de visão (FOV) para a detecção de limas fraturadas (13,14), segundo canal mésio vestibular (15), fraturas radiculares (16) e defeitos de furca (17). Eftekhar et al (17), ao compararem dois tamanhos de *voxel* (0.150 mm e 0.300 mm) na detecção de defeitos de furca, revelaram que o menor *voxel* foi mais sensível para furcas grau I e II. Para avaliação de fraturas radiculares, valores menores de *voxel* também obtiveram maior sensibilidade (16).

O tamanho de *voxel*, isoladamente, não implica em aumento da dose de radiação (18). Entretanto, dependendo dos protocolos pré-estabelecidos pelos fabricantes de cada tomógrafo, sua diminuição está relacionada ao aumento do tempo de exposição, levando consequentemente ao aumento da dose de radiação (18). Considerando o princípio ALADA (“*as low as diagnostically acceptable”*) em que a dose deve ser a mínima possível para alcançar o resultado desejado (19), torna-se importante a investigação de protocolos, para detecção de istmos, que utilizem menor dose de radiação, mas que também sejam suficientes para um correto diagnóstico.

Apesar de estudos prévios (20, 21, 22) terem investigado a presença de istmo em diferentes situações, por meio de exames de TCFC, a variação de parâmetros de aquisição para sua avaliação ainda permanece carente de exploração. Desta forma, o objetivo no presente estudo foi analisar, em exames de TCFC, se o tamanho do FOV e do *voxel* influenciam na avaliação do istmo de molares inferiores.

2 ARTIGO CIENTÍFICO

Artigo científico enviado para publicação no periódico *Journal of Endodontics*, qualis CAPES A1. A estruturação do artigo baseou-se nas instruções aos autores preconizados pelo periódico (ANEXO A).

Title page

Do FOV and voxel sizes influence the evaluation of isthmus in mandibular molars? A CBCT study.

Tauana R Lopes Macário, DDS[a], Francielle Silvestre Verner, DDS, MSc, PhD[b], Saulo Machado Piccolo[c], Esra Ece Çakmak, DDS, MSc[d], Nejlan Eratam, DDS[d], MSc, Kıvanç Kamburoglu, DDS, MSc, PhD[d], Rafael Binato Junqueira, DDS, MSc, PhD[b].

[a]MSc student, Health Applied Sciences Master Program, Federal University of Juiz de Fora, Campus GV, Governador Valadares, Minas Gerais, Brazil. taumacario@hotmail.com

[b]PhD, Professor, Health Applied Sciences Program and Department of Dentistry, Federal University of Juiz de Fora, Campus GV, Governador Valadares, Minas Gerais, Brazil.

francielle.verner@ufjf.br , rafael.binato@ufjf.br

[c] MSc student, Department of Dental Materials and Prosthesis, São Paulo University, Ribeirão Preto, São Paulo, Brazil

saulo.pic@usp.br

[d]Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Ankara University, Ankara, Turkey

Corresponding author:

Professor Rafael Binato Junqueira

Address: Av Moacir Paleta 1167, São Pedro, Governador Valadares, Minas Gerais, Brazil. ZIP: 35.020-360

Phone: +55 32 991490663 E-mail: rafael.binato@ufjf.br

Authorship Declaration:

All authors listed above certify that they have contributed significantly to this work, agree with the manuscript, and take public responsibility for the content, including participation in the manuscript's concept, design, analysis, writing, or review.

Significance:

The non-identification of isthmuses in mandibular molars may contribute to endodontic treatment failure. The search for a CBCT protocol that allows for a better assessment of this structure contributes to the correct diagnosis and treatment plan, increasing the success rates.

Acknowledgments:

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

The authors deny any conflicts of interest related to this study

ABSTRACT

Introduction: In this study, we analyzed, through cone-beam computed tomography (CBCT) scans, whether the size of the field of view (FOV) and voxel influence the evaluation of isthmuses in mandibular molars. **Methods:** Forty human mandibular molars were submitted to microcomputed tomography to obtain the gold standard. Then, they were scanned (ProMax® 3D Max) using seven acquisition protocols, varying in FOV size (10 x 5.5 cm and 5 x 5.5 cm) and voxel (0.400 mm, 0.200 mm, 0.100 mm and 0.075 mm). Two examiners classified the presence and type of isthmus on a five-point scale. To compare the frequency of isthmus detection in each protocol with the gold standard, the chi-square test was conducted. Sensitivity, specificity and accuracy values were calculated for each protocol. **Results:** Intra- and inter-examiner agreement was verified using the weighted Kappa test and ranged from substantial to almost perfect. The presence of isthmuses was underestimated, especially with a 0.400-mm voxel, regardless of the FOV used. The protocol with 10 x 5.5-cm FOV and 0.200-mm voxel presented the greatest sensitivity and accuracy and the lowest specificity values. Upon comparing all accuracy values, protocol 2 (larger FOV) was better than protocols 4, 5 and 7. **Conclusion:** Regardless of FOV, the voxel

size did not influence the evaluation of isthmuses in mandibular molars. The selection of the most appropriate protocol will depend on each clinical situation' particularities.

INTRODUCTION

Knowledge of the root canal system's anatomy and its variations helps address the challenges associated with endodontic treatment (1). Several features can integrate this system's anatomical complexity, such as secondary and lateral canals and isthmuses (2). The isthmus is defined as a narrow, ribbon-shaped communication between two root canals, which contains pulp tissue, also known a corridor or transverse anastomosis (3). It is a particularly challenging structure for endodontists because it can contain true niches for the proliferation of microorganisms, contributing to treatment failure (3).

The incidence of isthmuses among molars has been investigated in the literature (4, 5, 6, 7). Estrela et al (4) evaluated it in a population of 618 individuals by CBCT. Its frequency was 87.9% in the first and 66.3% in the second mandibular molars. Tahmasbi et al (5) found a frequency of 69.6% of isthmuses in mesial roots of first molars. Other studies have shown prevalence ranging from 55.5% to 97.2% (6, 7).

Because the isthmus's structure resembles a fine mesh, its presence can hamper an effective chemical-mechanical preparation (2,3), hindering the reduction of microbial infection in the root canal system (8). The instruments work in the main canal whereas on isthmuses, cleaning and disinfection mainly depend on irrigators' and medications' chemical effects (2).

Imaging exams are essential at all stages of endodontic treatment, either for initial evaluation of root anatomy at the end of treatment to verify the filling quality or in the postoperative control. Periapical radiography is the first choice because it is cheaper and more accessible and requires a smaller radiation dose than CBCT (9). However, in complex cases, such as isthmuses, CBCT becomes the best alternative (10) because it enables a more accurate diagnosis by eliminating overlaps and allowing for three-dimensional visualization of structures in the various orientation planes (11).

During the acquisition of CBCT images, the use of various parameters can improve the diagnosis of endodontic conditions (12,13,14). Previous studies included various voxel and FOV sizes for the detection of fractured files (13,14), second mesiobuccal canal (15), root fractures (16) and furcation defects (17). Eftekhar et al (17) compared two voxel sizes (0.150 mm and 0.300 mm) in the detection of furcation defects and found that the smaller voxel was more sensitive. For the evaluation of root fractures, the smaller voxel also produced higher sensitivity values (16).

The voxel size alone does not lead to an increase in the radiation dose (18). However, depending on the protocols each CBCT scanner's manufacturers pre-establish, its decrease is related to the increase in exposure time, leading to an increase in the radiation dose (18). Considering the ALADA (*as low as diagnostically acceptable*) principle in which the dose should be the smallest possible to achieve the desired result (19), it is important to investigate protocols for isthmus detection that use a lower dose of radiation but are also sufficient for a correct diagnosis.

Although in previous studies (20, 21, 22), researchers have investigated the presence of isthmus in various situations, through CBCT exams, the variation of acquisition parameters for its evaluation remains lacking in exploration. Therefore, the aim of this study was to determine, in CBCT scans, whether the FOV and voxel sizes influence the evaluation of isthmuses in mandibular molars.

MATERIAL AND METHODS

The present study was conducted after approval by the Ethics Committee on Research with Human Beings of the Federal University of Juiz de Fora - UFJF according to protocol n. 3.675.856/2019.

Sample selection and preparation

Forty-five freshly extracted mandibular first and second human molars were selected from a biorepository and previously submitted to digital periapical radiography for their choice. Only molars with sound root sections were included. Deciduous and third molars were excluded in addition to those that presented fused roots, endodontic treatment, intraradicular retainers, fractured file in the root canals, internal or external

root resorption, obliterated canals, pulp calcifications and roots with incomplete rhizogenesis. Teeth with cracks and root fractures were also excluded, diagnosed by the transillumination technique with high-power LED 1200mW/cm^2 (Radii Cal, SDI, Victoria, Australia). After the inclusion and exclusion criteria were applied, 40 teeth were used for the study.

The sample was submitted to scraping and straightening of the root surface, followed by bathing in an ultrasonic bowl for 30 minutes (Cristófoli, Londrina, Brazil) so that any remaining cementum bone tissue was removed. All teeth's crowns were sectioned at the limit of the amelocementary junction using a metallographic cutter (ISOMET 1000 Precision Saw; Buehler, Lake Bluff, IL, USA) to prevent the identification of teeth by the examiners.

Acquisition of images

All teeth were submitted to a micro-computed tomography (micro-CT) examination (Super-Argus PET/CT - Sedecal USA Inc., Madrid, Spain) to obtain the reference gold standard (23). Images were acquired at 40 kVp, 140 mA and with a voxel of 0.03 mm.

For CBCT images, each tooth was placed in the alveolar cavities properly prepared from mandibular molars from a dry skull along with its jaw, which was covered with 2 cm of red wax as a soft-tissue-equivalent material. The ProMax® 3D Max device (Planmeca, Helsinki, Finland) was used, adopting the acquisition protocols described in table 1.

Evaluation of images

Two specialists jointly evaluated the micro-CT scans (oral radiology and endodontics), both with more than ten years of experience, to establish the gold standard, verifying the presence or absence of isthmuses in the cervical, middle and apical root thirds. When present, the isthmus was classified as complete (true connection between the buccal and lingual canals) or incomplete (extension of the buccal and/or lingual canal toward the center of the root) (22). The AMIDE software (a medical imaging data examiner, available at amide.sf.net) was used.

Two radiologists and one endodontist individually evaluated the CBCT examinations, all with at least five years of experience and instructed on the study

methodology. They classified the presence or absence of isthmuses in the cervical, middle and apical thirds of the mesial root of the mandibular molars on a 5-point scale: 1 - definitely absent, 2 - probably absent, 3 - uncertainty, 4 - probably present, 5 - definitely present. The cases that were classified with a score of 4 or 5 were also classified according to the type of isthmus. For the evaluation of CBCT images, the Software Romexis Viewer (Planmeca, Helsinki, Finland) was used dynamically to analyze all reconstruction plans.

To ensure the evaluations' reliability, CBCT images of healthy mandibular molars (n=8) were selected from a database (obtained with the same equipment used in this study). They were evaluated and reevaluated in a 20-day interval for calculation of intra- and inter-examiner agreement. The evaluations began only after at least substantial agreement was obtained (24).

All evaluations were performed on a 24' monitor (Full HD, LG 24MP400-B - Seoul, South Korea) located in a room with ideal luminance and under the same observation conditions. The examiner could use the zoom, brightness and contrast tools as needed.

Statistical analysis

The weighted Kappa test was used to verify intra- and inter-examiner agreement. The Chi-Square test was conducted to compare the acquisition protocols in relation to the gold standard. Sensitivity, specificity and accuracy values (area under the ROC curve) were calculated for each of the CBCT acquisition protocols. The values of the area under the ROC curve (AUC) were compared using the method of Delong et al (25). The program used for statistical analysis was MedCalc (version 11.2.1.0) ($p<0.05$).

RESULTS

Intra- and inter-examiner agreement ranged from 0.675 (substantial agreement) to 0.843 (almost perfect agreement) (26).

Table 2 provides the relative frequency of the presence or absence of isthmuses. In general, the presence of isthmuses was underestimated, especially

using a 0.400-mm voxel, regardless of the FOV size. Although protocol 7 presented the frequencies closest to the gold standard, the chi-square test indicated a significant difference in the detection of isthmuses in all protocols (P<0.001). Analysis of the classification of isthmuses revealed that this protocol overestimated the presence of incomplete isthmuses and underestimated the presence of complete isthmuses.

Table 3 shows the sensitivity, specificity and AUC. Table 4 shows the P values obtained by comparing all accuracies. Protocol 2 had greater statistically values than protocols 4, 5 and 7.

Considering the higher FOV (10 x 5.5 cm), the highest sensitivity (0.673) and accuracy (0.723) values were obtained using the 0.200-mm voxel, which presented, however, the lowest specificity (0.726). There was no difference between the accuracy values (table 4). Considering the FOV of 5 x 5.5 cm, the greatest sensitivity (0.717) and accuracy (0.698) values were obtained when the 0.150-mm voxel was used. The lowest specificity (0.631) was obtained with the 0.075-mm voxel. The comparison of accuracy revealed no difference between the protocols of smaller FOVs (table 4).

DISCUSSION

For an effective endodontic treatment, knowledge of root canals' internal anatomy is essential. Although several instrumentation and irrigation methods have been studied to overcome the anatomical complexities (27, 28, 29, 30), none of them ensures maximum effectiveness in cleaning and shaping an isthmus. The presence of necrotic remains and remnants of pulp tissue can be a substrate for microorganisms and enable their propagation, increasing the chances of maintaining the infection and contributing to endodontic failure (31). This clinical concern makes studies like this relevant because better conditions for assessing isthmuses may contribute to the investigation of more effective strategies for its approach.

Various tools are used to evaluate dental anatomy, such as micro-CT, restricted to laboratory research, and CBCT, increasingly used in endodontists' clinical routines. Although in some previous studies, researchers have analyzed the prevalence of isthmuses in mandibular molars (4, 5, 6), the variation of CBCT image acquisition parameters for its evaluation constitutes a gap in the literature. Considering

that the FOV and voxel size can influence the analysis of endodontic conditions in multiple ways (20, 21, 22), this study becomes relevant.

In the present work, we aimed to identify the best parameter according to the possibilities the ProMax® 3D Max tomograph (Planmeca, Helsinki, Finland) offered. Seven CBCT image acquisition protocols were evaluated, which were compared with each other and with the images obtained by micro-CT, established as the gold standard. In a descriptive analysis, protocol 7 was the closest to the gold standard in the frequency of isthmus detection, possibly because a smaller voxel brings a higher resolution to the image (32). Therefore, a sharper image would make identifying the presence or absence of an isthmus easier. However, the comparison of frequencies by the chi-square test revealed that none of them were statistically similar to the gold standard ($P<0.001$).

Tolentino et al (20) used two CBCT scanners with different protocols (8 x 8 cm and 0.125 mm / 4 x 4 cm and 0.08 mm) and compared them with micro-CT. Unlike in the present study, both protocols were similar to the gold standard in comparing the frequencies of identified isthmuses. Rodrigues et al (21) also obtained different results when comparing two voxel sizes with the gold standard because the frequency of isthmus detection using the smaller voxel was statistically similar to the reference.

Considering the accuracy, protocols with larger FOV (10 x 5.5 cm) produced higher values, diverging from Mouzinho-Machado et al (15), who used three voxel sizes with a 5 x 5 cm FOV. Accuracy, sensitivity and specificity increased as the voxel size decreased. Uysal et al (16), in a similar assay, also evaluated three voxels but with an 8 x 8 cm FOV, obtaining the same results. The comparison of the accuracies of all protocols revealed that the 10 x 5.5 cm FOV and 0.200-mm voxel protocol was statistically superior to three of the four protocols with limited FOV. These findings allow us to question the use of the smallest voxel available in any case in endodontics because for the evaluation of isthmuses in mandibular molars, the results indicated that the three voxels used with larger FOV and the four voxels used with limited FOV obtained statistically similar accuracy. Therefore, the choice of the most indicated protocol should consider the principle of ALADA, evaluating the exposure time and radiation dose, according to each device. Because only one CBCT scanner was used in this work, the need for further research comparing other devices for this purpose is emphasized.

In endodontic practice, smaller FOVs are normally used because they are a smaller area to be visualized, following the recommendation of the American and European Associations of Endodontics (33, 34). However, considering this study's results, one could ask which clinical situations would require the use of a larger FOV. An example would be a patient who requires endodontic treatment on two teeth on opposite sides of the arch. Considering the radiation dose (table 1), instead of two CBCT scans with limited FOV, only one with a larger FOV could be performed, exposing the patient less. According to Hung et al (35), the use of a larger FOV does not always imply larger radiation doses for the patient. However, it may have a lower DAP due to advanced techniques in which the device has a preprogrammed low-dose mode. Therefore, the amount of radiation the patient receives would no longer be a hindrance to the use of larger FOVs.

The American and European Associations of Endodontics (33, 34) do not indicate CBCT in every case of non-surgical endodontic treatment and do not directly mention isthmuses as an indication for this exam. However, in their statements, both include cases of complex anatomy as indicative of a request for CBCT. If we consider isthmuses an anatomical complexity, as previously described (2,3), CBCT will be indicated for a more detailed evaluation of this morphology before endodontic intervention. Because the prevalence of isthmuses in mandibular molars has been reported as high (exceeding 85%) (4, 7), it may be suggested that CBCT be indicated as the standard exam for the treatment of these teeth.

Considering this study's limitations, regardless of the FOV, the voxel size did not influence the evaluation of isthmuses in mandibular molars. Therefore, the selection of the most appropriate protocol will depend on each clinical situation's particularities.

REFERENCES

1. Keles A, Keskin C. A micro-computed tomographic study of band-shaped root canal isthmuses, having their floor in the apical third of mesial roots of mandibular first molars. **Int Endod J**. 2017; 51(2): 240-6.

2. Siqueira Junior JF, Rôças IDN, Marceliano-Alves MF, Pérez AR, Ricucci D. Unprepared root canal surface areas: causes, clinical

implications, and therapeutic strategies. **Braz Oral Res**. 2018; 32(1): 65-72.

3. Kim S, Jung H, Kim S, Shin SJ, Kim E. The Influence of an Isthmus on the Outcomes of Surgically Treated Molars: A Retrospective Study. **J Endod.** 2016; 42(7): 1029-34.

4. Estrela C, Rabelo LEG, de Souza JB, Alencar AHG, Estrela CRA, Neto MDS, Pécora JD. Frequency of Root Canal Isthmi in Human Permanent Teeth Determined by Cone-beam Computed Tomography. **J Endod.** 2015; 41(9): 1535-9.

5. Tahmasbi M, Jalali P, Nair MK, Barghan S, Nair UP. Prevalence of Middle Mesial Canals and Isthmi in the Mesial Root of Mandibular Molars: An In Vivo Cone-beam Computed Tomographic Study**. J Endod.** 2017; 43(7): 1080-83.

6. Xu S, Dao J, Liu Z, Zhang Z, Lu Y, Zeng X. Cone-beam computed tomography investigation of middle mesial canals and isthmuses in mandibular first molars in a Chinese population. **BMC Oral Health**. 2020; 20(1): 135-44.

7. Karunakaran JV, PremKumar MM, Aarthi G, Jayaprakash N, Kumar SS. Isthmus Incidence in Human Permanent Mandibular First Molars of a South Indian Population: A Cone-Beam Computerized Tomographic Study. **Journal of Pharmacy and Bioallied Sciences.** 2019; 11(2): 648-73.

8. Natanasabapathy V, Arul B, Srinivasan V, Santosh SS, Vasudevan A, Arockiam S, Namasivayam A, Deivanayagam K, Srinivasan MR. Removal of accumulated hard tissue debris from mesial root of mandibular molars evaluated using micro-CT - a systematic review and network meta-analysis. **Evid Based Dent.** 2021; 22(4):

9. Salineiro FCS, Kobayashi-Velasco S, Braga MM, Cavalcanti MGP. Radiographic diagnosis of root fractures: a systematic review, meta-analyses and sources of heterogeneity. **Dentomaxillofac Radiol.** 2017; 46(8):

10. Giudice RL, Nicita F, Puleio F, Alibrandi A, Cervino G, Lizio AS, Pantaleo G. Accuracy of Periapical Radiography and CBCT in Endodontic Evaluation. **Int J Dent.** 2018.

11. Helvacioglu-Yigit D, Demirturk Kocasarac H, Bechara B, Noujeim M. Evaluation and Reduction of Artifacts Generated by 4 Different Root-

end Filling Materials by Using Multiple Cone-beam Computed Tomography Imaging Settings. **J Endod**. 2016; 42(2): 307-14.

12. Pinto MGO, Melo SLS, Suassuna FCM, Marinho LE, Leite JBS, Batista AUD, Bento PM, Melo DP. Influence of size of field of view (FOV), position within the FOV, and scanning mode on the detection of root fracture and observer's perception of artifacts in CBCT images. **Dentomaxillofac Radiol.** 2021; 50(6): 20200563.

13. Baratto-Filho F, Freitas JV, Tomazinho FSF, Gabardo MCL, Mazzi-Chaves JF, Sousa-Neto MD. Cone-Beam Computed Tomography Detection of Separated Endodontic Instruments. **J Endod.** 2020; 46(11): 1776-1781.

14. Koç C, Sönmez G, Yilmaz F, Karahan S, Kamburoğlu K. Comparison of the accuracy of periapical radiography with CBCT taken at 3 different voxel sizes in detecting simulated endodontic complications: na ex vivo study. **Dentomaxillofac Radiol.** 2018; 47(4): 20170399.

15. Mouzinho-Machado S, Rosado LPL, Coelho-Silva F, Neves FS, Haiter-Neto F, De-Azevedo-vaz SL. Influence of Voxel Size and Filter Application in Detecting Second Mesiobuccal Canals in Cone-beam Computed Tomographic Images. **J Endod.** 2021; 47(9): 1391-1397.

16. Uysal S, Akcicek G, Yalcin ED, Tuncel B, Dural S. The influence of voxel size and artifact reduction on the detection of vertical root fracture in endodontically treated teeth. **Acta Odontol Scand.** 2021; 79(5): 354-358.

17. Eftekhar M, Kaviani H, Rouzmeh N, Torabina A, Baghban AA. Effect of voxel size on detection of fenestration, dehiscence and furcation defects using cone-beam computed tomography. **Oral Radiol.** 2021; 37(4): 667-686.

18. De Melo LPL, Oenning ACC, Nadaes MR, Nejaim Y, Neves FS, Oliveira ML, Freitas DQ. Influence of acquisition parameters on the evaluation of mandibular third molars through cone beam computed tomography. **Oral Surg Oral Med Oral Pathol Oral Radiol.** 2017; 124(2): 183-190.

19. Jaju PP, Jaju SP. Cone-beam computed tomography: Time to move from ALARA to ALADA. **Imaging Sci Dent.** 2015; 45(4): 263-5.

20. Tolentino ES, Amoroso-Silva PA, Alcalde MP, Yamashita FC, Iwaki LCV, Rubira-Bullen IRF, Duarte MAH. Comparison of limited- and large-volume cone-beam computed tomography using a small voxel size for

detecting isthmuses in mandibular molars. **Imaging Sci Dent.** 2021; 51(1):27-34.

21. Rodrigues CT, JACOBS F, Vasconcelos KF, Lambrechts P, Rubira-Bullen IRF, Gaêta-Araujo H, Oliveira-Santos C, Duarte MAH. Influence of CBCT-based volumetric distortion and beam hardening artefacts on the assessment of root canal filling quality in isthmus-containing molars. **Dentomaxillofac Radiol**. 2021; 50(5):20200503.

22. Oliveira MLB, Junqueira RB, Kamburoğlu K, Eratam N, Çakmak EC, Sönmez G, Küçük Ö, Verner FS. Assessment of the Metal Artifact Reduction Tool for the Detection of Root Isthmus in Mandibular Molars with Intraradicular Posts in Cone-beam Computed Tomographic Scans. **J Endod**. 2021; 47(10):1583-1591.

23. Tayman MA, Kamburoglu K, Kuçuk O, et al. Comparison of linear and volumetric measurements obtained from periodontal defects by using cone beam-CT and micro-CT: an in vitro study. **Clin Oral Investig.** 2019; 23(5): 2235–44.

24. Rosado LPL, Barbosa IS, Junqueira RB, Martins APVB, Verner FS. Morphometric analysis of the mandibular fossa in dentate and edentulous patients: A cone beam computed tomography study**. J Prosthet Dent** 2021;125(5): 758.

25. DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. **Biometrics**.1988; 44(3): 837-45.

26. Landis JR, Koch GG. The measurement of observer agreement for categorical data. **Biometrics.**1977; 33(1): 159–74.

27. Natanasabapathy V, Arul B, Srinivasan V, Santosh SS, Vasudevan A, Arockiam S, Namasivayam A, Deivanayagam K, Srinivasan MR. Removal of accumulated hard tissue debris from mesial root of mandibular molars evaluated using micro-CT - a systematic review and network meta-analysis. **Evid Based Dent.** 2021;

28. Andrade-Junior CV, Batista RM, Marceliano-Alves M, Alves FRF, Silva EJNL. Efficacy of a new Activation Device in Irrigant Penetration Into Simulated Lateral Canals. **Eur Endod J**. 2016; 1(1): 1-4.

29. Cai M, Cai Y, Yang R, Xu Z, Neelakantan P, Wei X. Impact of agitation/activation strategies on the antibiofilm potential of sodium hypochlorite/etidronate mixture in vitro. **BMC Oral Health.** 2022; 22(1): 201.

30. Alves FRF, Andrade-Junior CV, Marceliano-Alves MF, Pérez AR, Rôças IN, Versiani MA, Sousa-Neto MD, JC, Jr JFS. Adjunctive Steps for Disinfection of the Mandibular Molar Root Canal System: A Correlative Bacteriologic, Micro-Computed Tomography, and Cryopulverization Approach. **J Endod**. 2016; 42(11): 1667-1672.

31. Silva EJNL, Carvalho CR, Belladonna FG, Prado MC, Lopes RT, De-Deus G, Moreira EJL. Micro-CT evaluation of different final irrigation protocols on the removal of hard-tissue debris from isthmus-containing mesial root of mandibular molars. **Clin Oral Investig**. 2019; 23(2): 681-687.

32. Dong T, Xia L, Cai C, Yuan L, Ye N, Fang B. Accuracy of in vitro mandibular volumetric measurements from CBCT of different voxel sizes with different segmentation threshold settings. **BMC Oral Health.** 2019;19(1): 206.

33. Patel S, Brown J, Semper M, Abella F, Mannocci F. European Society of Endodontology position statement: Use of cone beam computed tomography in Endodontics: European Society of Endodontology (ESE) developed by**. Int Endod J.** 2019; 52(12): 1675-1678.

34. Special Committee to Revise the Joint AAE/AAOMR Position Statement on use of CBCT in Endodontics. AAE and AAOMR Joint Position Statement: Use of Cone Beam Computed Tomography in Endodontics 2015 Update. **Oral Surg Oral Med Oral Pathol Oral Radiol.** 2015; 120(4): 508-12.

35. Hung KF, Hui L, Yeung AWK, Jacobs R, Leung YY, Bornstein MM. An analysis of patient dose received during cone-beam computed tomography in relation to scan settings and imaging indications as seen in a dental institution in order to establish institutional diagnostic reference levels. **Dentomaxillofac Radiol.** 2022; 51(5): 20200529.

Table 1. CBCT image acquisition protocols

Protocol	kV	mA	T(s)	DAP (mGy.cm^2)	Field of view (FOV) (cm)	Voxel (mm)
1	96	4	6	261	10 X 5.5	0.400
2	96	5.6	12	728	10 X 5.5	0.200
3	96	7.1	15	1153	10 X 5.5	0.150
4	96	4	6	149	5 X 5.5	0.400
5	96	5.6	12	415	5 X 5.5	0.200
6	96	7.1	15	657	5 X 5.5	0.150
7	96	7.1	15	657	5 X 5.5	0.075

Table 2. Relative frequency of absence and presence (type) of isthmus, and crosstab comparison between tested protocols and the gold standard

		Isthmus			
		Absent	**Incomplete**	**Complete**	**P value* (Ref. standard. x protocol)**
Gold Standard		23.3%	16.7%	60%	-
FOV (cm)	**Voxel (mm)**				
10 x 5.5	**0.400**	56.7%	6.4%	36.9%	< 0.0001
	0.200	41.9%	10%	48.1%	< 0.0001
	0.150	37.5%	13.3%	49.2%	< 0.0001
5 x 5.5	**0.400**	53.9%	8.6%	36.9%	< 0.0001
	0.200	43.1%	11.9%	45%	< 0.0001
	0.150	38.6%	13.9%	47.5%	< 0.0001
	0.075	27.8%	21.9%	50.3%	< 0.0001

*P value – Chi-squared Test

Table 3. Sensitivity, specificity, and area under the ROC curve (AUC) for each of the FOV and voxels tested

FOV (cm)	Voxel (mm)	Sensitivity	Secificity	AUC
10 x 5.5	0.400	0.572	0.821	0.707
	0.200	0.673	0.726	0.723
	0.150	0.521	0.821	0.706
5 x 5.5	0.400	0.529	0.761	0.673
	0.200	0.641	0.666	0.672
	0.150	0.717	0.642	0.698
	0.075	0.677	0.631	0.671

Table 4. **P values* obtained after AUC comparisons**

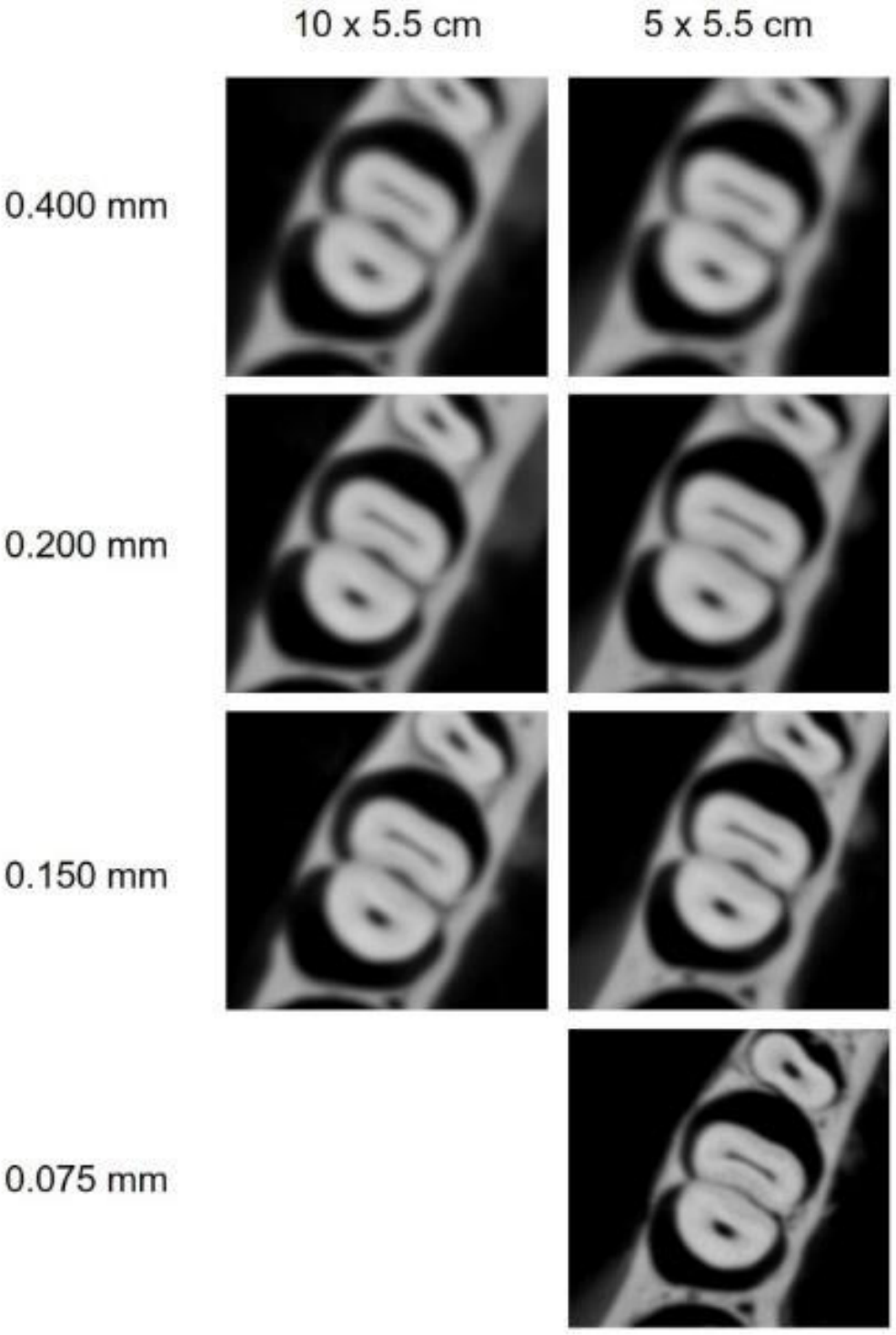
FOV (cm) / Voxel (mm)	**10 x 5.5 / 0.400**	**10 x 5.5 / 0.200**	**10 x 5.5 / 0.150**	**5 x 5.5 / 0.400**	**5 x 5.5 / 0.200**	**5 x 5.5 / 0.150**	**5 x 5.5 / 0.075**
10 x 5.5 / 0.400	-	0.527	0.968	0.138	0.232	0.713	0.278
10 x 5.5 / 0.200	-	-	0.471	0.022	0.030	0.234	0.011
10 x 5.5 / 0.150	-	-	-	0.210	0.134	0.733	0.292
5 x 5.5 / 0.400	-	-	-	-	0.984	0.317	0.963
5 x 5.5 / 0.200	-	-	-	-	-	0.240	0.975
5 x 5.5 / 0.150	-	-	-	-	-	-	0.334
5 x 5.5 / 0.075	-	-	-	-	-	-	-

* Delong et al. (1988)

Figure legend

FIGURE 1 – ProMax 3D axial slices of a mandibular molar with the tested protocols

FIGURE 1



3 CONCLUSÃO

Considerando as limitações deste estudo, independentemente do FOV utilizado, o tamanho do voxel não influenciou na avaliação de istmos em molares inferiores. Portanto, a escolha do protocolo mais adequado dependerá das particularidades de cada situação clínica.

REFERÊNCIAS

1. KELES, A.; KESKIN, C. A micro-computed tomographic study of band-shaped root canal isthmuses, having their floor in the apical third of mesial roots of mandibular first molars. **Int Endod J**, v. 51, n. 2, p. 240-6, 2018.

2. SIQUEIRA JUNIOR, J. F.; RÔÇAS I. D. N.; MARCELIANO-ALVES, M. F.; PÉREZ A. R.; RICUCCI D. Unprepared root canal surface areas: causes, clinical implications, and therapeutic strategies. **Braz Oral Res**, v. 32, n. 1, p. 65-72, 2018.

3. KIM S.; JUNG H.; KIM S.; SHIN S. J.; KIM E. The Influence of an Isthmus on the Outcomes of Surgically Treated Molars: A Retrospective Study. **J Endod**, v. 42, n. 7, p. 1029-34, 2016.

4. ESTRELA C.; RABELO L. E. G.; DE SOUZA J. B.; ALENCAR A. H. G.; ESTRELA C. R. A.; NETO M. D. S.; PÉCORA J. D. Frequency of Root Canal Isthmi in Human Permanent Teeth Determined by Cone-beam Computed Tomography. **J Endod**, v. 41, n. 9, p. 1535-9, 2015.

5. TAHMASBI M.; JALALI P.; NAIR M. K.; BARGHAN S.; NAIR U. P. Prevalence of Middle Mesial Canals and Isthmus in the Mesial Root of Mandibular Molars: An In Vivo Cone-beam Computed Tomographic Study**. J Endod**, v. 43, n. 7, p. 1080-83, 2017.

6. XU S.; DAO J.; LIU Z.; ZHANG Z.; LU Y.; ZENG X. Cone-beam computed tomography investigation of middle mesial canals and isthmuses in mandibular first molars in a Chinese population. **BMC Oral Health**, v. 20, n. 1, p. 135-44, 2020.

7. KARUNAKARAN J. V.; PREMKUMAR M. M.; AARTHI G.; JAYAPRAKASH N.; KUMAR S. S. Isthmus Incidence in Human Permanent Mandibular First Molars of a South Indian Population: A Cone-Beam Computerized Tomographic Study. **Journal of Pharmacy and Bioallied Sciences**, v. 11, n. 2, p. 648-73, 2019.

8. NATANASABAPATHY V.; ARUL B.; SRINIVASAN V.; SANTOSH S. S.; VASUDEVAN A.; AROCKIAM S.; NAMASIVAYAM A.; DEIVANAYAGAM K.; SRINIVASAN M. R. Removal of accumulated hard tissue debris from mesial root of mandibular molars evaluated using micro-CT - a systematic review and network meta-analysis. **Evid Based Dent**, v. 22, n. 4**,** 2021.

9. SALINEIRO F.C. S.; KOBAYASHI-VELASCO S.; BRAGA M. M.; CAVALCANTI M. G. P. Radiographic diagnosis of root fractures: a systematic review, meta-analyses and sources of heterogeneity. **Dentomaxillofac Radiol**, v. 46, n. 8, 2017.

10. GIUDICE R. L.; NICITA F.; PULEIO F.; ALIBRANDI A.; CERVINO G.; LIZIO A. S.; PANTALEO G. Accuracy of Periapical Radiography and CBCT in Endodontic Evaluation. **Int J Dent,** 2018.

11. HELVACIOGLU-YIGIT D.; DEMIRTURK-KOCASARAC H.; BECHARA B.; NOUJEIM M. Evaluation and Reduction of Artifacts Generated by 4 Different Root-end Filling Materials by Using Multiple Cone-beam Computed Tomography Imaging Settings. **J Endod**, v. 42, n. 2, p. 307-14, 2016.

12. PINTO M. G. O.; MELO S. L. S.; SUASSUNA F. C. M.; MARINHO L. E.; LEITE J. B. S.; BATISTA A. U. D.; BENTO P. M.; MELO D. P. Influence of size of field of view (FOV), position within the FOV, and scanning mode on the detection of root fracture and observer's perception of artifacts in CBCT images. **Dentomaxillofac Radiol**, v. 50, n. 6, 2021.

13. BARATTO-FILHO F.; FREITAS J. V.; TOMAZINHO F. S. F.; GABARDO M. C. L.; MAZZI-CHAVES J. F.; SOUSA-NETO M. D. Cone-Beam Computed Tomography Detection of Separated Endodontic Instruments. **J Endod**, v. 46, n. 11, p. 1776-81, 2020.

14. KOÇ C.; SÖNMEZ G.; YILMAZ F.; KARAHAN S.; KAMBUROĞLU K. Comparison of the accuracy of periapical radiography with CBCT taken at 3 different voxel sizes in detecting simulated endodontic complications: an ex vivo study. **Dentomaxillofac Radiol**, v. 47, n. 4, 2018.

15. MOUZINHO-MACHADO S.; ROSADO L. P. L.; COELHO-SILVA F.; NEVES F. S.; HAITER-NETO F.; DE-AZEVEDO-VAZ S. L. Influence of Voxel Size and Filter Application in Detecting Second Mesiobuccal Canals in Cone-beam Computed Tomographic Images. **J Endod**, v. 47, n. 9, p. 1391-97, 2021.

16. UYSAL S.; AKCICEK G.; YALCIN E. D.; TUNCEL B.; DURAL S. The influence of voxel size and artifact reduction on the detection of vertical root fracture in endodontically treated teeth. **Acta Odontol Scand**, v. 79, n. 5, p. 354-58, 2021.

17. EFTEKHAR M.; KAVIANI H.; ROUZMEH N.; TORABINA A.; BAGHBAN A. A. Effect of voxel size on detection of fenestration, dehiscence and furcation defects using cone-beam computed tomography. **Oral Radiol**, v. 37, n. 4, p. 667-86, 2021.

18. DE MELO LPL, OENNING ACC, NADAES MR, NEJAIM Y, NEVES FS, OLIVEIRA ML, FREITAS DQ. Influence of acquisition parameters on the evaluation of mandibular third molars through cone beam computed tomography. **Oral Surg Oral Med Oral Pathol Oral Radiol.** 2017; 124(2): 183-190.

19. JAJU P. P.; JAJU S. P. Cone-beam computed tomography: Time to move from ALARA to ALADA. **Imaging Sci Dent**, v. 45, n. 4, p. 263-65, 2015.

20. TOLENTINO E. S.; AMOROSO-SILVA P. A.; ALCALDE M. P.; YAMASHITA F. C.; IWAKI L. C. V.; RUBIRA-BULLEN I. R. F.; DUARTE M. A. H. Comparison of limited- and large-volume cone-beam computed tomography using a small voxel size for detecting isthmuses in mandibular molars. **Imaging Sci Dent**, v. 51, n. 1, p. 27-34, 2021.

21. RODRIGUES C. T.; JACOBS F.; VASCONCELOS K. F.; LAMBRECHTS P.; RUBIRA-BULLEN I. R.F.; GAÊTA-ARAUJO H.; OLIVEIRA-SANTOS C.; DUARTE M. A. H. Influence of CBCT-based volumetric distortion and beam hardening artefacts on the assessment of root canal filling quality in isthmus-containing molars. **Dentomaxillofac Radiol**, v. 50, n. 5, 2021.

22. OLIVEIRA M. L. B.; JUNQUEIRA R. B.; KAMBUROĞLU K.; ERATAM N.; ÇAKMAK E. C.; SÖNMEZ G.; KÜÇÜK Ö.; VERNER F. S. Assessment of the Metal Artifact Reduction Tool for the Detection of Root Isthmus in Mandibular Molars with Intraradicular Posts in Cone-beam Computed Tomographic Scans. **J Endod**, v. 47, n. 10, p. 1583-91, 2021.

23. TAYMAN M. A.; KAMBUROGLU K.; KUÇUK O.; ET AL. Comparison of linear and volumetric measurements obtained from periodontal defects by using cone beam-CT and micro-CT: an in vitro study. **Clin Oral Investig**, v. 23, n. 5, p. 2235-44, 2019.

24. ROSADO L. P. L.; BARBOSA I. S.; JUNQUEIRA R. B.; MARTINS A. P. V. B.; VERNER F. S. Morphometric analysis of the mandibular fossa in dentate and edentulous patients: A cone beam computed tomography study**. J Prosthet Dent**, v. 125, n. 5, p. 758-64, 2021.

25. DELONG E. R.; DELONG D. M.; CLARKE-PEARSON D. L. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. **Biometrics**, v. 44, n. 3, p. 837-45, 1988.

26. LANDIS J. R.; KOCH G. G. The measurement of observer agreement

for categorical data. **Biometrics**, v. 33, n. 1, p. 159-74, 1977.

27. NATANASABAPATHY V.; ARUL B.; SRINIVASAN V.; SANTOSH S. S.; VASUDEVAN A.; AROCKIAM S.; NAMASIVAYAM A.; DEIVANAYAGAM K.; SRINIVASAN M. R. Removal of accumulated hard tissue debris from mesial root of mandibular molars evaluated using micro-CT - a systematic review and network meta-analysis. **Evid Based Dent,** 2021.

28. ANDRADE-JUNIOR C. V.; BATISTA R. M.; MARCELIANO-ALVES M.; ALVES F. R. F.; SILVA E. J. N. L. Efficacy of a new Activation Device in Irrigant Penetration Into Simulated Lateral Canals. **Eur Endod J**, v. 1, n. 1, p. 1-4, 2016.

29. CAI M.; CAI Y.; YANG R.; XU Z.; NEELAKANTAN P.; WEI X. Impact of agitation/activation strategies on the antibiofilm potential of sodium hypochlorite/etidronate mixture in vitro. **BMC Oral Health**, v. 22, n. 1, p. 201-205, 2022.

30. ALVES F. R. F.; ANDRADE-JUNIOR C. V.; MARCELIANO-ALVES M. F.; PÉREZ A. R.; RÔÇAS I. N.; VERSIANI M. A.; SOUSA-NETO M. D.; PROVENZANO J. C.; SIQUEIRA-JUNIOR J. F. Adjunctive Steps for Disinfection of the Mandibular Molar Root Canal System: A Correlative Bacteriologic, Micro-Computed Tomography, and Cryopulverization Approach. **J Endod**, v. 42, n. 11, p. 1667-72, 2016.

31. SILVA E. J. N. L.; CARVALHO C. R.; BELLADONNA F. G.; PRADO M. C.; LOPES R. T.; DE-DEUS G.; MOREIRA E. J. L. Micro-CT evaluation of different final irrigation protocols on the removal of hard-tissue debris from isthmus-containing mesial root of mandibular molars. **Clin Oral Investig**, v. 23, n. 2, p. 681-87, 2019.

32. DONG T.; XIA L.; CAI C.; YUAN L.; YE N.; FANG B. Accuracy of in vitro mandibular volumetric measurements from CBCT of different voxel sizes with different segmentation threshold settings. **BMC Oral Health**, v. 12, n. 1, p. 206, 2019.

33. PATEL S.; BROWN J.; SEMPER M.; ABELLA F.; MANNOCCI F. European Society of Endodontology position statement: Use of cone beam computed tomography in Endodontics: European Society of Endodontology (ESE) developed by**. Int Endod J**, v. 52, n. 12, p. 1675-78, 2019.

34. SPECIAL COMMITTEE TO REVISE THE JOINT AAE/AAOMR POSITION STATEMENT ON USE OF CBCT IN ENDODONTICS. AAE and AAOMR Joint Position Statement: Use of Cone Beam Computed

Tomography in Endodontics 2015 Update. **Oral Surg Oral Med Oral Pathol Oral Radiol**, v. 120, n. 4, p. 508-12, 2015.

35. HUNG K. F.; HUI L.; YEUNG A. W. K.; JACOBS R.; LEUNG Y. Y.; BORNSTEIN M. M. An analysis of patient dose received during cone-beam computed tomography in relation to scan settings and imaging indications as seen in a dental institution in order to establish institutional diagnostic reference levels. **Dentomaxillofac Radiol**, v. 51, n. 5, 2022.

ANEXO A

Instruções para submissão no periódico ***"Journal of Endodontics"***, disponível em: https://www.jendodon.com/content/authorinfo

ANEXO B

UFJF - UNIVERSIDADE FEDERAL DE JUIZ DE FORA - MG

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação do istmo radicular em molares inferiores por tomografia computadorizada de feixe cônico

Pesquisador: FRANCIELLE SILVESTRE VERNER

Área Temática:

Versão: 2

CAAE: 18990319.7.0000.5147

Instituição Proponente: UNIVERSIDADE FEDERAL DE JUIZ DE FORA UFJF

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 3.675.856

Apresentação do Projeto:

Apresentação do projeto esta clara, detalhada de forma objetiva, descreve as bases científicas que justificam o estudo, de acordo com as atribuições definidas na Resolução CNS 466/12 de 2012.

Objetivo da Pesquisa:

Objetivo da pesquisa é comparar a influência de diferentes protocolos de aquisição das imagens de TCFC na detecção de istmos radiculares em molares inferiores. Está bem delineado, apresenta clareza e compatibilidade com a proposta, tendo adequação da metodologia aos objetivos pretendido, de acordo com as atribuições definidas na Norma Operacional CNS 001 de 2013, item 3.4.1 - 4.

Avaliação dos Riscos e Benefícios:

Os riscos que o projeto apresenta estão caracterizados e adequadamente descritos, considerando que os indivíduos não sofrerão qualquer dano ou prejuízo pela participação ou pela negação de participação na pesquisa e benefícios esperados. Estão caracterizados como riscos mínimos, e as formas de mitigação também foram apresentadas:" Os riscos envolvidos na pesquisa consistem em risco mínimo, tanto para os voluntários doadores de dentes (que não serão afetados por nenhum procedimento da metodologia desta pesquisa, nem serão identificados a partir dos dentes), quanto para os pesquisadores que executarão as etapas metodológicas. Estes manipularão os

Endereço: JOSE LOURENCO KELMER S/N
Bairro: SAO PEDRO **CEP:** 36.036-900
UF: MG **Município:** JUIZ DE FORA
Telefone: (32)2102-3788 **Fax:** (32)1102-3788 **E-mail:** cep.propesq@ufjf.edu.br

UFJF - UNIVERSIDADE FEDERAL DE JUIZ DE FORA - MG

Continuação do Parecer: 3.675.856

dentes utilizando equipamentos de proteção individual, minimizando os riscos de contaminação"

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, e se apresenta em consonância com os princípios éticos norteadores da ética na pesquisa científica envolvendo seres humanos elencados na resolução 466/12 do CNS e com a Norma Operacional Nº 001/2013 CNS.

Considerações sobre os Termos de apresentação obrigatória:

Foram adequadamente apresentados FOLHA DE ROSTO devidamente preenchida, TERMO DE CONSENTIMENTO LIVRE ESCLARECIDO e DECLARAÇÃO de infraestrutura e de concordância com a realização da pesquisa de acordo com as atribuições definidas na Norma Operacional CNS 001 de 2013 item 3.3 letra h.

Conclusões ou Pendências e Lista de Inadequações:

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 com a Norma Operacional Nº 001/2013 CNS. Data prevista para o término da pesquisa:dezembro de 2021.

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 com a 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.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1408767.pdf	09/10/2019 13:57:22		Aceito
Projeto Detalhado / Brochura Investigador	projetodetalhadoalt.pdf	09/10/2019 13:57:06	FRANCIELLE SILVESTRE VERNER	Aceito
Folha de Rosto	_folha_de_rosto_.pdf	09/09/2019 12:27:18	FRANCIELLE SILVESTRE	Aceito

Endereço: JOSE LOURENCO KELMER S/N
Bairro: SAO PEDRO **CEP:** 36.036-900
UF: MG **Município:** JUIZ DE FORA
Telefone: (32)2102-3788 **Fax:** (32)1102-3788 **E-mail:** cep.propesq@ufjf.edu.br

UFJF - UNIVERSIDADE FEDERAL DE JUIZ DE FORA - MG

Continuação do Parecer: 3.675.856

TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Biorrepositorio.pdf	05/09/2019 16:44:40	FRANCIELLE SILVESTRE VERNER	Aceito
Declaração de Manuseio Material Biológico / Biorepositório / Biobanco	declaracao_biorrepositorio.pdf	05/09/2019 16:43:40	FRANCIELLE SILVESTRE VERNER	Aceito
Declaração de Instituição e Infraestrutura	declaracao_infraestrutura.pdf	05/09/2019 16:43:16	FRANCIELLE SILVESTRE VERNER	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

JUIZ DE FORA, 01 de Novembro de 2019

Assinado por:
Jubel Barreto
(Coordenador(a))

Endereço: JOSE LOURENCO KELMER S/N
Bairro: SAO PEDRO **CEP:** 36.036-900
UF: MG **Município:** JUIZ DE FORA
Telefone: (32)2102-3788 **Fax:** (32)1102-3788 **E-mail:** cep.propesq@ufjf.edu.br