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Identification of simulated periapical diseases using five different diagnostic imaging methods

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ABSTRACT

Objectives: To assess and compare five diagnostic imaging methods used in the identification of periapical diseases, of different diameters, mechanically simulated.
Methods: The sample of the present study consisted of 12 dried human mandibles. Digital panoramic radiography, conventional and digital periapical radiography (charged couple device and photo-stimulable phosphor plate), and high-resolution cone beam computed tomography (CBCT) were previously performed to exclude regions presenting periapical lesions or similar conditions, which then formed the control and experimental groups. Then, periapical diseases were progressively produced with drills of different diameters, thus creating lesions of different sizes. The different image diagnosis methods were applied after each lesion produced. The data were assessed using the Kappa test, ROC curve graphs and Cochran's Q test. The significance level was set at 0.05.
Results: The images obtained with conventional film and digital panoramic radiography showed the worse results (0.65 and 0.55, respectively), and statistically significant differences compared to the controls ($p < 0.05$) for lesions artificially produced with #6 drill. With regard to high-resolution CBCT, the area values were found to be high for all lesion sizes.
Conclusion: Conventional periapical radiography and digital panoramic radiography did not provide satisfactory images for the identification of incipient periapical diseases. The high-resolution CBCT showed high accuracy in the diagnosis of periapical diseases in both regions evaluated, and proved to be the most reliable method for the identification of initial periapical diseases (1.8 mm).

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Identificação de lesões periapicais, simuladas mecanicamente, por meio de 5 diferentes métodos de diagnóstico por imagem

Palavras-chave:
Tomografia computadorizada de feixe cónico
Radiografia digital
Lesão periapical

RESUMO

Objetivos: Avaliar e comparar 5 métodos de diagnóstico por imagem utilizados na identificação de lesões periapicais, de diferentes diâmetros, simuladas mecanicamente.
Métodos: A amostra do presente estudo consistiu de 12 mandíbulas humanas secas. Radiografias panorâmicas digitais, radiografias periapicais convencionais e digitais (dispositivo de carga acoplada e placa de fósforo fotoestimulável), e tomografia computadorizada de feixe cónico de alta resolução (TCFC) foram realizadas previamente para excluir regiões com lesões periapicais ou condições semelhantes. Em seguida, lesões periapicais foram produzidas progressivamente por meio de brocas de diferentes diâmetros, criando lesões periapicais de diferentes tamanhos. Os diferentes métodos de diagnóstico por imagem foram executados após a produção de cada lesão. Os dados foram avaliados por meio dos testes Kappa, curva ROC e Q de Cochran, com nível de significância de 0,05.
Resultados: As imagens de radiografias panorâmica digital eperiapical convencional apresentaram os piores resultados (0,65 e 0,55, respectivamente) e com diferença estatisticamente significante quando comparados ao grupo controle ($p < 0,05$), em lesões artificialmente produzidas com a broca 6. Com relação à TCFC de alta resolução, os valores de área obtidos foram elevados em todas as lesões.
Conclusão: Radiografias panorâmicas digitais e periapicais convencionais não proporcionaram imagens satisfatórias para a identificação de lesões periapicais incipientes. A TCFC de alta resolução demonstrou elevada acurácia no diagnóstico de lesões periapicais em todas as regiões avaliadas, e provou ser o método mais confiável para a identificação de lesões periapicais iniciais (1,8 mm).

Introduction

The interpretation of radiographic images continues to be the primary tool for the diagnosis of bone lesions in the maxilla-mandibular complex. Diagnosis of periapical pathology has always been an issue of interest to doctors. Identification of evidence of periapical pathology in nonvital teeth is central to treatment planning, and the disease is diagnosed when periapical radiolucency is present.[1,2] Panoramic radiography (PR) is the image diagnosis method used for tracking oral and maxillofacial diseases such as dental caries, periodontitis, tumorous lesions, degenerative bone changes in temporomandibular joints and inflammatory diseases (e.g., periapical diseases).[3] Conventional periapical radiographs (CPR) are the most commonly used method for the evaluation of the periapical region, but superposition of bone structures can impair visualization of periapical radiolucent images, primarily with initial lesions. Anatomical features adjacent to the area of interest may result in poor contrast and therefore increased difficulty in assessing periapical tissues.[4]

Conventional radiographs have been replaced by digital systems. The digital radiography have the advantages of immediately generating images, eliminating chemical processing, and allowing images to be manipulated, stored and sent to other practitioners, thus increasing the ability to visualize the images and determine a diagnosis.[5] However, the main advantage for the patient is the radiation dose reduction in digital systems. About radiation exposure and based on ALARA principle (the desired amount of information must be obtained with the smallest possible amount of radiation), digital systems showed a dose reduction from 30% to 70% compared to E-Film speed.[6]

Tachibana and Matsumoto, in 1990, were pioneers in research on the use of computed tomography in endodontics.[7] However, this method also has disadvantages, such as high radiation doses and high examination costs.[2,8,9] Due to these limitations, cone beam computed tomography (CBCT) was developed for the dentistry market to provide visualization of bone and alveolar structures in three dimensions using lower radiation dose.[10] In general, CBCT can be categorized into large, medium, and limited volume units based on the size of their field of view (FOV). The size of the FOV describes the scan volume of the CBCT machine and is dependent on the detector size and shape, beam projection geometry and the ability to collimate the beam. Beam collimation limits the radiation exposure to the region of interest and ensures that an optimal FOV can be selected based on disease presentation. The radiation dose applied in CBCT is lower, mainly when the exam is performed with a reduced field of view.[10] However, CBCT still has exposure radiation larger than periapical radiography. Two recommendations are given[10]: (1) Intraoral radiographs should be considered the imaging modality of choice in the evaluation of the endodontic of the patient, and (2) limited FOV in CBCT should be considered the imaging modality of choice for diagnosis in patients who