Prevalence of periapical lesions in endodontically treated teeth at the FOP-UPE specialization clinic

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Rosana Maria Coelho Travassos[1], Paulo Maurício Reis de Melo Júnior[2], Sílvio Emanuel Acioly Conrado de Menezes[3], Kassia Regina de Santana[4], Pedro Guimarães Sampio Trajano dos Santos[5], Juliana Perez Leyva Ataíde[6], Rodolfo Scavuzzi Carneiro Cunha[7], Ailton Coelho de Ataíde Filho[8], Eudoro de Queiroz Marques Filho[9], José Neilton de Araujo Júnior[10] and Victoria Souza Rocha[11]

ABSTRACT

The aim of the present study is to determine the prevalence of periradicular lesions in permanent anterior teeth treated endodontically and in teeth with intraradicular retainers through the analysis of periapical radiographs. A survey of 1000 radiographs of patients treated endodontically in the dental clinics of the Faculty of Dentistry of Pernambuco – FOP/UPE was carried out, constituting a sample of 467 radiographs that fit the established criteria. In the analysis, the following data were collected: canal obturation limit, presence or absence of periapical lesion, homogeneity of the filling material characterized as without failure or with failure when presence of any radiotransparency in the root canal, presence or absence of the space between the intraradicular retainer and filling material and coronary sealing classified as adequate or inadequate. Through the data obtained, the highest frequencies corresponded to maxillary incisor teeth. It indicated that the filling

[1] University of Pernambuco, Brazil
E-mail: rosana.travassos@upe.br
ORCID: https://orcid.org/0000-0003-4148-1288
[2] University of Pernambuco, Brazil
E-mail: paulo.reis@upe.br.
ORCID: https://orcid.org/0000-0001-9926-5348
[3] Tiradentes University
E-mail: drsilviomenezes@yahoo.com.br
ORCID: https://orcid.org/0009-0003-6693-7875
[4] Federal University of Pernambuco, Brazil
E-mail: Kassiaupe2016.1@gmail.com
ORCID: https:// 0000-0002-4187-5933
[5] Faculty of Dentistry of Recife
E-mail: pedroguimaraessampaio@gmail.com
ORCID: https://orcid.org/0009-0001-5720-603X
[6] E-mail: juliana.ataide@upe.br
ORCID:https://orcid.org/0009-0000-3673-7651
[7] Recife School of Dentistry, Brazil
E-mail: scavuzzi@gmail.com
ORCID: https://orcid.org/0000-0001-7110-848X
[8] Recife School of Dentistry, Brazil
E-mail: ailtonataide@hotmail.com
ORCID: https://orcid.org/0000-0002-8105-4259
[9] Recife School of Dentistry, Brazil
E-mail: eudoromarques@hotmail.com
ORCID: https://orcid.org/0000-0001-9794-0311
[10] Faculty of Dentistry of Recife
E-mail: jnaraujo84@gmail.com
ORCID: https://orcid.org/0009-0001-4153-838X
[11] Faculty of Dentistry of Recife
E-mail: vitoriasouzarocha1@gmail.com
ORCID: https://orcid.org/0009-0007-3184-0431

limit characterized as beyond the apical foramen was the one with the highest rate of periapical lesion presence (66.7%), followed by the filling limit characterized as exact (32.4%).

Keywords: Endodontics, Quality of treatment, Periapical radiograph, Periapical lesion.

INTRODUCTION

Endodontics is the specialty of Dentistry that studies and treats changes in the dental pulp, periradicular tissues, and is dedicated to evaluating their morphology, physiology and pathology. The study and practice of this area involve basic and clinical sciences, including the biology of healthy pulp, the etiology, diagnosis, prevention and treatment of pulp diseases and injuries, associated or not, with periradicular alterations.

The pulp tissue is protected by its natural structure from external bacterial agents of the oral cavity, however, when factors such as caries, dental trauma, or restorations allow the integrity of the tissues that protect the pulp to be broken, they contribute to the emergence of infections in the dentin-pulp complex, possibly causing pulp and periapical disease.

As a treatment for these infections, endodontic treatment is performed, which has currently favored the increase in success rates thanks to new techniques, instruments, materials and, mainly, the awareness of professionals. However, this fact does not dispense with clinical and radiographic control of endodontic treatments after their completion.

"There are several methods to diagnose periradicular lesions, among them is the radiographic method. Among the possibilities of radiographic takes, periapical radiography is the one that makes it possible to observe the periradicular region, providing a detailed view of the root and surrounding structures. " (FREITAS, 1998).

"Longitudinal studies carried out in places where endodontic treatment is performed in controlled environments point to a 95% chance of success. " (STRINDBERG, 1956; SJÖGREN et al., 1997). "However, in studies where this controlled environment does not exist, or even when endodontic treatment is performed by general practitioners, the success rate can vary between 35% and 60%. " (ERIKSEN et al., 1995; SEGURA-EGEA et al., 2004).

Based on these premises, the objective of the present study is to determine the prevalence of periradicular lesions in permanent anterior teeth treated endodontically and in teeth with intraradicular retainers through the analysis of periapical radiographs.

LITERATURE REVIEW

PERIAPICAL LESION OF ENDODONTIC ORIGIN: BASIC CONCEPTS, DIAGNOSIS AND TREATMENT

The presence of bacteria in the root canal system is the primary etiological factor for the development of an AP. Radiolucidity is an important characteristic for its diagnosis (KAKEHASHI, STANLEY, FITZGERALD, 1965).

Inflammation of the periodontium is called apical periodontitis. Its etiology is related to the infection of the tissues of the root canal system and the surrounding dentin, in some cases, also of

tissues beyond the apical foramen. Typically, the lesion is located at the vertex of the root, but communications may exist along the root surface and the lesions may develop laterally or in the furcation region (HUUMONEN, ØRSTAVIK, 2002).

Inflammation and destruction of periradicular tissues caused by etiological agents of endodontic origin is called PA. In general, it is a sequelae of root canal infection seen as a dynamic interaction between microbial factors and host defense at the interface between the root pulp and the periodontal ligament. The name periapical lesion encompasses several histopathological categories of AP. The most frequent gateways for endodontic infections are the result of caries, clinical procedures, and traumas that induce cracks or fractures. The goal of endodontic treatment is to eliminate root canal infection and prevent reinfectionthrough filling. When treatment is done properly, BP cures with bone regeneration, which is characterized by the gradual decrease and disappearance of radiolucent on preservation radiographs. Most failures occur when treatment procedures, mainly of a technical nature, have not reached a satisfactory level for the control and elimination of infection (NAIR, 2004).

Apical periodontitis is a general term used to describe the inflammatory periapical process that occurs in response to the presence of microorganisms and other irritants within a tooth's root canal system. Although many patients may develop apical periodontitis without symptoms over a long period of time, it is very likely that acute exacerbation will occur at some point and then various signs and symptoms will become evident. However, there are other conditions that mimic BP, such as an advanced stage of pulpitis, periodontal disease, occlusal trauma, an accident that damages the periodontal ligament, and multiple tumors or cysts. Therefore, it is essential to understand the progressive nature of the periapical disease process, how and why the various stages occur, so that the pathology can be diagnosed and treated appropriately. Diagnosis will usually be based on the clinical and radiographic manifestations and the results of various tests that may be performed as part of a routine dental exam. Teeth with acute primary BP have very marked sensitivity to percussion and pain when pressure is applied. Radiographically, a slight thickening of the ligament space and some loss of the lamina dura around the apex of the tooth root may be found, or present in a normal manner. The dental element may have some mobility and the onset of pain is usually sudden and unexpected. The patient will experience considerable pain when biting and touching the tooth and possibly a sensation of pressure building up in the periapical region. Secondary acute BP presents with pain symptoms similar to those present in primary acute BP, but there will be more clinical and radiographic signs to aid in the diagnosis, since it is an acute exacerbation of a chronic BP. There may be a history of previous episodes of pain or discomfort, but many patients may not remember such details. Radiographically there will be a radiolucent around the root vertex of the involved tooth and loss of the hard lamina. The size of radiolucency, which can range from just a thickening of the

periodontal ligament space in early cases to a large radiolucent area, is time dependent. However, these lesions progress at varying rates so the size of the area is not necessarily indicative of the time it has been present. Chronic BP varies in its clinical presentation, since this general term represents different histological conditions of the periapical disease process. Patients are usually unaware of any symptoms associated with these lesions, which are often only indicated as findings on routine radiographic examination. The pulp may be necrotic and infected, or the canal pulped and infected, or the canal may be treated and infected in the meantime. There will be no response to sensitivity tests and radiographically it will present a periapical radiolucent area. The tooth will show mild pain on percussion or palpation and will present slight mobility (ABBOTT, 2004).

Periapical granuloma and periapical cyst (true and bay) have exactly the same clinical and radiographic appearance. Although some authors state that clinical and radiographic diagnosis is based on periapical radiolucency or scathing of the periodontal ligament, the appearance of the radiolucency margins cannot be used as a diagnostic criterion to distinguish these conditions. It is now recognized that a well-defined margin indicates only a long-standing lesion that is slowly increasing in size, whereas a diffuse border probably indicates a rapid expansion of the lesion. The size of the radiolucent is also irrelevant for diagnosis, since small or large lesions can be granulomas, abscesses, or cysts. Therefore, the accurate diagnosis can only be conceived through histopathological examination. Since cysts and root granulomas are difficult to distinguish and their treatments are identical, they can be classified clinically with the general term of "apical periodontitis". These pathological processes are dynamic and the pathological entities are interchangeable, thus this more generalized diagnostic term is more valuable for clinical use (ABBOTT, 2004).

Lateral periodontal cysts, odontogenic keratocysts, dentigerous cysts, developmental cysts, central giant cell granuloma, traumatic bone cyst, and some forms of ameloblastoma must somehow be differentiated from apical periodontitis (COTTI, 2010).

Most apical periodontitis is found associated with endodontically treated teeth. The quality of this treatment is of fundamental importance for the favorable prognosis of healing the lesion (ECKERBOM, FLYGARE, MAGNUSSON, 2007). Scar tissue may develop after conventional endodontic treatment, causing complications in the diagnosis of periapical lesions (HUUMONEN, ØRSTAVIK, 2002).

Adequate endodontic treatment consists of completely filling the root canal and, if possible, the accessory canals, eliminating and preventing the re-entry of the aggressive agents. In patients with periapical lesions, endodontic treatment is successful when the lesion regression is radiographically observed over a few months. On the other hand, failure, in well-performed

treatments, should be associated with local factors, such as the great variability of apical morphology (CONSOLARO, 2008).

In vitro studies have shown that bacteria and their products penetrate filled channels after a certain period of exposure to artificial saliva or bacterial culture. Ricucci, Gröndahl and Bergenholtz (2000) conducted a retrospective cohort study of 55 patients who had teeth with an obturated canal, exposed to the oral environment due to caries or absent restorations to evaluate this infiltration. The cases were combined one by one with regard to the initial pulp and periapical diagnosis, time elapsed after the end of endodontic treatment, type of teeth, patient's age, and technical quality of the filling. Only cases with a follow-up period of three years or more were included. The last observation radiography was submitted to a blinded evaluation.A total of 14 osteolytic lesions were observed. In 43 of the 55 pairs combined (78%), the periapical conditions remained identical. In 9 pairs, a periapical lesion was present in the "open tooth" category (P>0.10), while in 3 pairs, a periapical lesion was observed exclusively in the "intact tooth" group. The authors concluded that the data suggest that the problem of coronary infiltration may not be of as great clinical importance as demonstrated by numerous in vitro studies, provided that instrumentation and root filling are carefully performed.

According to Wu, Wesselink and Walton (2000), the apical limit of endodontic treatment is considered an important factor in the success of the treatment. The exact impact of this threshold is somewhat uncertain, and most publications on this topic are based on retrospective results. In vital teeth, the best success rate has been reported when procedures ended 2 to 3 mm short of the radiographic apex. With pulp necrosis, bacteria and their derivatives, as well as debris from the infected dentin, can remain in the most apical portion of the canal, compromising apical healing. In these cases, the best success rate was achieved when the procedures ended between 0 and 2 mm below the radiographic apex. When this measurement was greater than 2 mm or exceeded the radiographic apex, the success rate for infected channels was about 20% lower than when the limit was between 0 and 2 mm. Clinical determination of the anatomy of the apical canal is difficult and apical constriction is often absent. In accordance with the biological basis and clinical principles, instrumentation and filling should not extend beyond the apical foramen.

In order to evaluate the success rate of endodontic treatment in patients from the School of Dentistry of the University of Pernambuco, Brazil, Travassos, Caldas Júnior, Albuquerque (2003) conducted a retrospective cohort study using dental records from the sample composed of all patients treated in 1998 and 1999. Statistical analysis was performed using the Chi-square test and Fisher's exact test. Logistic regression models were used to confirm the effect of some variables on endodontic therapy. A total of 311 (75.9%) patients were women and 99 (21.1%) were men. Most cases (82.9%) were considered successful. Success was less frequent in patients with incomplete

primary education (55.6%) than in those with a higher level of education (89.7%). The vital condition of the pulp showed a statistically significant relationship with the success of endodontic therapy ($p < 0.05$). The authors concluded that it is possible to achieve high success rates when the causes of endodontic treatment failure are well controlled.

In order to identify and describe the individual factors associated with the incidence or persistence of apical periodontitis in a population, Kirkevang et al. (2007) randomly selected 616 individuals in 1997 to obtain a complete periapical record. In 2003, 77% of these patients retook the exams. All teeth were individually evaluated in the following items: caries, marginal bone level and dental restorations. Through logistic regressions, the authors tried to identify the risk factors for each individual and for each tooth to develop BP. Endodontic treatments, coronary restorations, primary caries lesions, and reduced marginal bone level have been associated with the incidence of BP in the individual. Regarding teeth, poor quality or absence of a coronary restoration, as well as the presence of an obturated root, primary caries lesions, reduced marginal bone level, and molar teeth increased the risk of developing BP. The quality of the endodontic filling was not associated with the incidence of BP, but the results suggest an association between the quality of the filling and the cure of BP.

The working length and filling of endodontic treatments is a controversial topic. For this reason, Moura et al. (2009) set out to determine the influence of root canal filling length on apical periodontitis detected by periapical radiography and cone beam computed tomography (CBCT). A total of 503 filled canals were evaluated. The distances from the radiographic apex to the tip of the filling material were measured and classified. The analysis of periapical radiographs showed that the fillings were between 1 and 2 mm from the apex in 88% of the anterior teeth, 89.3% of the premolars, and 95% of the molars. CBCT images showed that the fillings had the same length in 70% of the anterior teeth, 73.7% of the premolars, and 79% of the molars. The frequency of BP was significantly higher in molars than in the other groups of teeth, regardless of the method of diagnosis. BP was detected more frequently when CBCT was used and was present at all endodontic filling lengths.

CONSIDERATIONS ON RADIOGRAPHIC IMAGES

Radiography is an invaluable tool for the diagnosis, treatment guidance and preservation of pathologies, in addition to assisting in clinical follow-up studies. However, radiological findings do not always accurately reflect the existence of normal or pathogenic conditions in the periapical region. Differences in radiographic images of bones or other mineralized tissues depend on the thickness of the hard structure, the homogeneous composition of the tissue, and the angle at which the X-rays pass through the object. In addition, the transformation of the object that is three-

dimensional into a bidimensional image should be considered, which leads to the overlapping of anatomical structures. The radiographic visualization of lesions is influenced by the location of the lesions in different types of bone. Visualization is easier when the lesion is in or very close to the cortex, and more complicated when it is located in the endosteal region, and even less likely to be detected when it is in the region of spongy structure (BENDER, 1982).

Panoramic radiographic examinations may be sufficient for preliminary visualization of the patient's dentition as well as bone-related pathologies. These have become popular in dental diagnosis due to acceptable image quality, low radiation dose, and ease of obtainment. As it is an extra-oral method, it is more comfortable for the patient. However, this type of radiography may underestimate periapical lesions when compared with periapical radiographs (HUUMONEN, ØRSTAVIK, 2002).

Periapical radiographs are good aids in the diagnosis of endodontics, although they have limitations (COTTI et al., 1999). Taken in at least two different projections, these radiographs will allow a more specific visualization of the selected teeth, verify the presence and extent of caries, visualize the condition of the restorations, and diagnose a possible lesion (HUUMONEN, ØRSTAVIK, 2002).

The accuracy of periapical radiographs in detecting periapical bone defects is significantly higher than that of panoramic radiographs (ESTRELA et al., 2008a). However, no differences were observed when comparing digital and conventional periapical radiographs (STAVROPOULOS, WENZEL, 2007).

Changes in the mineralized tissue of the tooth and the bone structure adjacent to the site of inflammation form the radiographic basis for diagnostic procedures, detection and monitoring of chronic apical periodontitis (HUUMONEN, ØRSTAVIK, 2002).

Morphological variations of the apical region, bone density, x-ray angles, radiographic contrast and actual location of the periapical lesion influence the radiographic interpretation (ESTRELA et al. 2008a). However, when the signs of the disease are large and striking, interpretation problems are almost non-existent (HUUMONEN, ØRSTAVIK, 2002).

Conventional and digital radiographs enable the diagnosis of periapical diseases, but not their nature (GUNDAPPA, NG, WHAITES, 2006; RAGHAV et al., 2010).

One aspect to be considered is that, regardless of the method used to obtain the radiographic image, care must be taken to avoid misinterpretation, however, the use of conventional radiographic images for the detection of BP must be done with caution because of the high possibility of false-negative diagnosis. (ESTRELA et al, 2008b).

Frequent radiographic evaluation of healthy teeth for the sole purpose of detecting and monitoring the first signs of apical periodontitis is not usually indicated for radiation safety reasons (HUUMONEN, ØRSTAVIK, 2002).

Conventional radiography is, without a doubt, the most commonly used imaging modality to evaluate periapical lesions, because it is easy, inexpensive, and accessible. Digital radiography gained popularity as an alternative to conventional radiography because it gave the dentist the ability to perform the radiographic examination with reduced radiation exposure in addition to allowing the improvement of image quality through software (RAGHAV et al. 2010).

Digital radiography has several advantages and has become an indispensable diagnostic tool for many dentists in daily practice. The software of the X-ray machines allows immediate capture with less exposure to radiation and the improvement of images, favoring the diagnosis. However, inappropriate use of enhancement may adversely affect the diagnosis. On the other hand, digital information can be manipulated in order to alter the information contained in it (NAIR, NAIR, 2007).

Diagnostic, clinical and radiographic information will directly influence clinical decisions about the treatment of periapical bone lesions. An imaging system is effective when: (1) it can detect all lesions present in the jaws; (2) favors the anatomical location of lesions in the three spatial dimensions for diagnosis and treatment purposes (determine the shape and measurements of a lesion, determine the amount of cortical bone involved; visualize the relationship of a lesion with the tip of the root and the anatomical landmarks in the bones); (3) to guide a differential diagnosis of the lesions; and (4) to assist in the transoperative and postoperative periods. (COTTI, 2010)

Periapical radiographs were the reference standard for evaluating the healing of endodontic lesions. The Periapical Index (IAP) has been used as a classification system for the radiographic evaluation of BP. The PAI offers a visual reference scale (score related to reference radiographs and histological assessment of BP) and assigns a health status to the root, based on changes in bone mineral content in the periapical region. The score ranges from 1 (absence of pathologies) to 5 (propagation of the lesion within the bone) (ØRSTAVIK, HEREKES, ERIKSEN, 1986; COTTI, 2010)

To compare the information collected from periapical radiography and high-resolution computed tomography (CT) regarding the detection of periapcal lesions and their relationship with neighboring anatomical structures, Velvart, Hecker and Tillinger (2001) evaluated 50 patients with a periapical lesion. Patients with indication for perendodontic surgery were selected. The teeth involved were 6 mandibular premolars and 44 mandibular molars, totaling 80 roots. A computed tomography scan and a periapical radiography were requested for each case. All 78 lesions diagnosed during surgery were also visible with CT scans. In contrast, only 61 of the lesions were seen on

conventional radiographs. The mandibular canal can be identified radiographically in 31 cases, whereas on CT scan it can be observed in 100% of cases. The amount of cortical and trabecular bone and the thickness of the bone, as well as the three-dimensional extent of the lesion, can only be interpreted with computed tomography. The use of this exam provides additional information for planning and treatment in cases of surgery, which is beneficial not available on radiographs.

Gundappa, Ng and Whaites (2006) evaluated the efficacy of ultrasound, digital and conventional radiography in the differential diagnosis of periapical lesions. Fifteen patients aged between 13 and 40 years with periapical lesions associated with the upper or lower anterior teeth that required parendodontic surgery were selected. Conventional and digital periapical radiographs were obtained for the preoperative period. Provisional measures of the areas and diagnoses were made by three specialists (two dental radiologists and one endodontist) at three different times. Preoperative ultrasound examinations were performed and the images were evaluated by two specialists (sonographer and endodontist) for analysis of size, content, vascular supply, and a provisional diagnosis of cyst or granuloma. Parendodontic surgery was performed to allow histopathological investigation, which provided the gold standard diagnosis. All measures and results were compared and statistically analyzed. Both conventional and digital radiographs showed that periapical lesions were readily identified, but observers were unable to differentiate which type of lesion affected the patient. Dimensional measurements were subject to greater interobserver variation in digital radiography than in conventional radiography. Where the vestibular cortical bone had been resorbed the ultrasound was simple but underestimated the size of the lesions compared to the radiographs. In all 15 cases, the ultrasound diagnosis agreed with the histopathological gold standard. Thus, the authors concluded that the two methods of radiographs allow a diagnosis of the existence of periapical lesion, but not of its nature; While ultrasound underestimates the extent of the disease, but can provide accurate information about the pathological nature of the injury.

The accuracy of Cone Beam Computed Tomography (NewTom 3G) in detecting periapiacis bone defects was compared with intraoral periapical radiographs (Dixi2, Planmeca CCD sensor, and Insight film) by Stavropoulos and Wenzel (2007). Ten frozen pig mandibles had their soft tissues removed and were sectioned sagittitally to obtain three blocks on each side of the mandible containing the premolars and molars, with surrounding bone. All teeth were extracted with intact roots. Initially, 15 blocks were used to define the size of the bone defect and the exposure parameters, then the other 45 blocks were divided into three numerically identical groups. In one group, cylindrical defects of 1 x 1 mm were prepared beyond the limit of the apices of the cavities left by the extracted teeth; in the other group, defects of 2 × 2 mm were prepared in a similar way, while no defects were prepared in the last group. The teeth were reattached to their respective cavities and digital and conventional radiographs of all blocks were taken under reproducible

conditions. In addition, all blocks were submitted to CBCT with the same volumetric data and then reconstructed to provide sagittal and coronal sections in two dimensions. The evaluation of the images was performed by four calibrated examiners, classifying them as "present defect" or "no defect". Statistical analysis was performed with ANOVA, and the significance level was set at P <0.05. NewTom 3G was significantly better compared to digital and conventional radiographs. No difference was observed between the results of digital and conventional periapical radiosurgery.

In order to verify the accuracy of imaging methods for detecting apical periodontitis, Estrela et al. (2008a) obtained 888 imaging records from a consecutive sample of scans of patients with endodontic infection (1508 teeth), including cone beam computed tomography and panoramic and periapical radiographs. The sensitivity, specificity, predictive values, and accuracy of periapical and panoramic radiographs were calculated. The analysis of the characteristics of the operational receiver was performed to evaluate the diagnostic accuracy of the panoramic and periapical images. The prevalence of BP was significantly higher with CBCT. The overall sensitivity was higher in periapical radiographs compared to panoramic radiographs, 0.55 and 0.28 respectively. ROC curves, which measure the characteristics of the operating receptor, and area under the curve (AUC) with periapical radiography showed high accuracy for both periapical (AUC, 0.90) and panoramic (AUC, 0.84) radiographs, in cases of severe apical periodontitis in which there are exacerbated characteristics. Apical periodontitis was correctly identified with conventional methods when it showed an advanced stage. CBCT has been proven to be effective in identifying apical periodontitis.

In order to evaluate the efficacy of conventional radiography, digital radiography, and ultrasonography in the diagnosis of periapical lesions, Raghav et al. (2010) selected 21 patients aged between 15 and 45 years with well-defined periapical radiolucency associated with maxillary or mandibular anterior teeth that had an indication for parendodontic cirurgia or extraction. Three specialists examined the preoperative periapical radiographs and the digital images obtained by the parallelism technique using a charge-coupled device and gave their diagnosis. Then, ultrasound examination was performed and the images evaluated for size, content, and vascular supply by 3 sonographers. After surgery, the periapical tissues were analyzed for histopathological analysis, which is the gold standard for diagnosis. The data were statistically analyzed using SPSS, analysis of variance, and the k. The diagnostic accuracy of periapical lesions using conventional radiography was 47.6%, 55.6% with digital radiography and 95.2% ultrasound. The latter have the highest sensitivity and specificity: 0.95 and 1.00, respectively. Conventional and digital radiographs make it possible to diagnose periapical diseases, but not their nature, while ultrasound provides accurate information about the pathological nature of the lesions, which is of importance in prognosis. Therefore, ultrasound can be used as an adjunct to conventional or digital radiography in the diagnosis of periapical lesions.

Working length in endodontic treatments of deciduous teeth obtained through digital and conventional intraoral radiographs and electronic apical locator was compared by Ananthraj et al. (2011). An in vivo study was conducted on 30 deciduous teeth with pulpectomy idication in patients between 5 and 11 years of age. During pulpectomy, the working length was determined by digital radiography and apical locator. The measurements were then compared with the conventional method. Based on the results obtained, the authors found that the working length determined in deciduous molars using digital radiography and apical locator did not present a significant difference between the means of working length measurements, when compared with the conventional radiographic method. The apical locator is comparable to conventional radiography for the determination of the non-radiation working length in primary teeth. Intraoral digital radiography is the safest method to determine working length with significant reduction of radiation exposure. Thus, both techniques can be easily used as alternatives to conventional radiographic methods in determining the working length in primary teeth.

Digital radiographic imaging systems have undergone major improvements since their introduction. Its advantages over conventional radiographs include lower radiation doses, instant imaging, easier archiving and sharing of images, and manipulation of various properties that can aid in diagnosis. Tewary, Luzzo and Hartwel (2011) conducted a study where six observers evaluated 150 digital periapical radiographs of molars to determine which of the following conditions each dental element fit: normal periapical tissue, enlargement of the periodontal ligament, or presence of periapical radiolucency. The evaluators had full control over the radiography parameters through the Planmeca Dimaxis software. All images were viewed on the computer monitor in ideal viewing conditions. The same six observers re-evaluated the same 150 images three months later. The data were analyzed by comparing interobserver agreement, twice, and intraobserver agreement. Fleiss Kappa statistical analysis was used to measure the level of agreement between the evaluators. The kappa value for interobserver agreement for the first round of interpretation was 0.34 ($P < 0.001$), for the second round it was 0.35 ($P < 0.001$). The results indicate that the interpretation of a dental X-ray is subjective, regardless of whether conventional or digital radiographs are used. The factors that appear to have the greatest impact were the examiner's years of experience and the operator's familiarity with a particular digital system.

In a clinical study, Patel et al. (2012) compared the radiographic change in periapical status in roots determined using periapical digital radiographs compared with cone beam computed tomography (CBCT) 1 year after endodontic treatment. Periapical radiographs and CBCT of 123 teeth in 99 patients were evaluated one year after completion of endodontic treatment by a single operator and were compared with the diagnostic image. The presence or absence as well as the increase or decrease in the size of existing periapical radiolucent was evaluated by two examiners.

Paired comparison of the diagnostic results was performed using the McNemar or Stuart-Maxwell symmetry analysis tests. The rate of absence of periapical radiolucency for all roots was 92.% on periapical radiographs and 73.9% on CBCT. When this group was added to which the radiolucency size had decreased, the rates increased to 97.2% and 89.4%, respectively. A statistically significant difference in the result of the root diagnosis was found between radiography and CBCT in single-rooted teeth and buccal or mesiobuccal roots of multi-rooted teeth. Analysis by tooth revealed that the rate of "cured" was 87% through periapical radiographs and 62.5% using CBCT. This increased to 95.1% and 84.7%, respectively, when the group "cured". The results also demonstrated a statistically significant difference in diagnosis. Diagnosis using CBCT revealed a lower rate of "cure" and "cured" for root canal treatment when compared to periapical radiographs, especially in the roots of the molars. There was a 14-fold increase in failure rate when preoperative periapical radiolucency-free teeth were evaluated with CBCT compared to periapical radiographs at 1 year.

PREVALENCE STUDIES OF APICAL PERIODONTITIS IN POPULATIONS

The prevalence, quality of endodontic treatment and the occurrence of periapical lesions of a random sample of 967 individuals selected from the total population in a county in Sweden were evaluated by means of radiographs by Ödesjö et al. (1990). The relationship between the quality of endodontic treatment and the occurrence of periapical lesions was also analyzed. Of the selected individuals, 95% were examined. Of the 17430 teeth examined, 1492 (8.6%) underwent endodontic treatment. About 70% of the treated root canals were inadequately filled; 10% had overfilling. The prevalence of periapical lesions was 2.9%, and in teeth with a treated root canal it was 24.5%. There was no difference in the frequency of periapical lesions found in root canals with homogeneous filling at the correct limit compared to those improperly filled. Overfilling was related to a significantly higher frequency of periapical lesions.

With a random sample of about 3% of 50-year-old citizens of the city of Oslo, Eriksen and Bjertness (1991), through panoramic radiographs and periapical radiographs of all endodontically treated teeth evaluated the prevalence of apical periodontitis. The results showed the presence of lesions in 3.5% of all teeth present. Of the endodontically treated teeth, 44% had a radiolucent image detectable on periapical radiography. The authors demonstrated a statistically significant negative correlation between the quality of root fillings and the prevalence of apical periodontitis.

The objective of the study by Weiger et al. (1997) was to determine the periapex situation, the quality of root canal fillings and to estimate the endodontic treatment needs in a German population. Clinical and radiographic data and operational procedures performed in 1993 on 323 patients were evaluated. In 182 subjects, at least one tooth exhibited endodontic treatment performed, necrotic pulp, or irreversible pulpitis. Of the 7897 teeth examined, 215 (2.7%) underwent endodontic

treatment; of the teeth not treated endodontically, 122 (1.5%) did not respond to the sensitivity test and 53 were diagnosed with irreversible pulpitis. In the group of teeth with filled canals, 61% presented radiographic signs of periapical pathology. In teeth in which the pulp was not present, but which were not submitted to endodontic treatment, 88% presented an image suggestive of periapical lesion. Using the criterion for evaluating the limit and homogeneity of the filling material, the authors concluded that only 14% of the treatments were considered adequate. Regarding the total number of teeth that do not have a treated root canal, 2.3% require endodontic intervention. When the need for endodontic retreatment due to a deficient filling was taken into account, this percentage rose to 3.7%.

The epidemiological study by Marques, Moreira and Eriksen (1998) verified the prevalence of apical periodontitis and the quality of endodontic treatment, through the evaluation of 179 panoramic radiographs of residents of the city of Porto. The results indicated a prevalence of apical periodontitis in 27% of this population. The quality of 54% of the fillings observed was considered inadequate, but only 22% of the teeth treated endodontically had apical periodontitis.

To verify the prevalence of apical periodontitis as well as the technical standard of root canal treatment in Belgium, De Moor et al. (2000) examined 206 panoramic radiographs of adult patients at the University Hospital of Ghent verifying endodontic treatment, periapical conditions and coronal restorations. Of the 4617 teeth examined, 6.8% were treated endodontically. Periapical radiolucency was found in 6.6% of all teeth and in 40.4% of endodontically treated teeth. More than half of the fillings (56.7%) were classified as inadequate. The authors concluded that the need for endodontic treatment of this Belgian subpopulation was great and that the quality of the treatments performed was disappointing. Thus, they stated that there is still a need for improvements in the training and number of endodontists.

The prevalence and technical quality of root fillings, as well as the periapical status of endodontically treated teeth in a French subpopulation were verified by Boucher et al. (2002). Complete periapical charts of 208 patients were observed. Fillings are classified according to the density and dstance of the filling material termination and the radiographic apex. Periapical status was assessed using the Periapical Index. The type of coronary restoration and the presence of pins were also observed. At least one periapical lesion was observed in 63% of patients. Of the 8743 channels included in the survey, 23% were blocked. An acceptable standard of care was found in 21% of the roots, with 16% of the cases associated with signs of periapical disease. In the canals with unacceptable fillings, 27% had associated lesions. Pins were detected in 26% of the filled canals, with 29% of the cases associated with periapical injury. Intracoronary restoration was observed in 30% of the filled roots, of which 22% had periapical pathology. Extracoronal restoration was present in 60% of the endodontically treated roots, of which 24% showed radiographic signs of periapical

radiolucency. The remaining 10% of filled roots that did not have coronary restoration were associated with periapical pathology in 33% of cases. According to the authors, the results demonstrate a high prevalence of filled root canals with poor technical quality of treatment. Acceptable fillings were associated with a lower prevalence of periapical pathology. Pins were significantly associated with periapical pathology.

Lupi-Pegurier et al. (2002) determined the periapical status and quality of endodontic treatment of patients treated at the dental school of Nice, France, in 1998. Panoramic radiographs of patients seeking the Faculty of Dentistry for the first time were examined. The quality of the canal fillings and the periapical region of all teeth, except for the third molars, were evaluated. Statistical analyses were performed using the ANOVA, Chi-square, PLSD Fisher and Cohen Kappa tests. The research involved 344 patients: 180 women and 164 men. Male individuals had significantly fewer remaining natural teeth than females ($P<0.03$). Similarly, the mean number of filled teeth was lower for men ($P<0.01$). Non-endodontically treated teeth ($n = 6126$) had significantly fewer signs of periapical pathology than filled teeth ($n = 1429$) (1.7% vs 31.5%, $P<0.0001$). Most of the fillings were poorly executed. There was a significant correlation between the presence of periapical pathology and inadequate root canal fillings ($P<0.001$). The authors concluded that many root canal treatments were technically unsatisfactory in terms of quality and success of treatment, which leads to a need for endodontic re-treatment in the population examined.

The prevalence of apical periodontitis and the quality of endodontic fillings and restorations were determined in two Canadian populations by Dugas et al. (2003). Panoramic radiographs of 610 patients aged between 25 and 40 years were examined for the following items: missing teeth, presence of endodontically treated teeth, quality of these fillings, and presence of BP, according to the periapical index. Patients with treated root canaled teeth were invited for an interview and clinical examination so that the restorations could be inspected and reveal data such as the reason for extraction and what type of professional performed the root canal treatment. The association between the prevalence of BP in filled teeth and the quality of filling, restoration, and the person performing the treatment was examined using the chi-square test and the t-test. The prevalence of endodontically treated teeth was higher in Toronto (39%) than in Saskatoon (26%). The presence of PA in filled teeth was 44% in Toronto and 51% in Saskatoon, and was significantly associated with radiographs in which the filling material had low density, were below or beyond the working length. In relation to the type of professional who performed the treatment, there was no significant difference between general dentists and endodontists. The results also confirm that the quality of both the root filling and the restoration influence periapical health. The data clearly demonstrated the need for an improvement of filling and restoration patterns in order to improve the outcome and benefits associated with endodontic treatment.

To investigate the quality of root fillings and coronary restorations and their associations with periapical status in a Spanish adult population, Segura-Egea et al. (2004) examined 180 patients aged 37.1 ± 15.7 years. With the periapical radiographic chart complete, the periapical region of all endodontically treated teeth, excluding the third molars, were examined. The quality of the fillings was evaluated in terms of distance from the root vertex and the apical end of the filling material and lateral adaptation of this material in relation to the canal walls. Radiographic signs of restorations with excess or marginal infiltrations were also evaluated. Periapical status was assessed with the aid of the Periapical Index and statistical analyses were performed with the Cohen k test and logistic regression. Of the 93 teeth filled, 64.5% had apical periodontitis. This was associated with inadequate adaptation of the root canal filling, inadequate length of the filling material, and poor coronary restoration. Only 34.4% of the root fillings were adequate from a technical perspective. When endodontic filling and coronary restoration were adequate, the incidence of BP decreased to 31.3%. The authors concluded that the incidence of BP in filled teeth was high; in many cases, the filling of the canal was unsatisfactory; An adequate filling had a more significant impact on the outcome of the treatment than the quality of the coronary restoration.

Through panoramic radiographs, the quality of root fillings and the prevalence of apical periodontitis in an adult population of Ireland were evaluated by Loftus, Keating and McCartan (2005). A systematic sample of the clinical records and panoramic radiographs of 302 patients from Dublin Dental Hospital were examined by two unfamiliar examiners. The European Society of Endodontics guidelines were used to determine the quality of endodontic treatment. Of the 7427 teeth examined, 2% were filled. Apical periodontitis was evident in 1.6% of teeth without endodontic treatment, while 33.1% of individuals had at least one tooth with apical periodontitis. Of the filled teeth, 25% had apical periodontitis and 52.6% had fillings considered inadequate. There was a statistically significant ($P < 0.05$) and negative correlation between the quality of fillings and the prevalence of apical periodontitis. Posterior teeth treated endodontically had a higher prevalence of apical periodontitis compared to anterior teeth under the same conditions. The authors concluded that the quality of endodontic treatments in this Irish population was poor and the prevalence of apical periodontitis was high.

A cross-sectional study was conducted by Siqueira et al. (2005) to determine the prevalence of periradicular lesions in teeth that underwent root canal treatment in a Brazilian adult urban population. The quality of the fillings and coronary restorations and their associations with the periapical state of these teeth was also observed. The fillings of 2051 teeth, through periapical or panoramic radiographs, were classified as adequate or inadequate based on length and homogeneity. Coronary restorations of these same teeth were classified as adequate, inadequate or absent. Statistical results were obtained using the chi-square test. The overall success rate of root canal

treatments was 49.7%. Cases with adequate endodontic treatment and restoration had a success rate of 71%. When cases with proper treatment and inadequate restoration were evaluated, the success rate dropped to 65%. Cases with adequate treatment and absent restoration showed a success rate of 48%. Teeth with adequate treatment with inadequate restoration demonstrated a 38% success rate, whereas the combination of inadequate treatment and restoration resulted in a 25% success rate. Teeth with inadequate treatment and absent restoration showed the lowest success rate in this study (18%). The analysis of the data revealed that, when the filling of the root canal appeared to be adequate, the quality of the restoration did not significantly influence the results of the treatment. However, when a coronary restoration was absent, the success rate of properly treated canals was significantly reduced. The quality of the coronary restoration also significantly affected the outcome of teeth with inadequate filling. The results revealed a high prevalence of endodontically treated periradicular root lesions. In addition, the authors concluded that although coronary sealing had a significant impact on periradicular health, the quality of the canal system filling was the most important factor in ensuring the success of endodontic treatment.

To estimate the prevalence of teeth with apical periodontitis and technically defective fillings in an adult population of Belarus, Kabak and Abbott (2005) evaluated 1423 panoramic radiographs of patients over 15 years of age who did not seek urgent dental care and who were attending the School of Dentistry of the Medical University of Belarus for the first time during the period from January 1 to December 31, 2001. The quality of the fillings and the eryapical status of all teeth, except the third molars, were evaluated. The data were statistically analyzed using the chi-square test and odds ratio. In 20% of the teeth there was some matter inside the root canals. BP was more associated with molar teeth (23%) than premolars (14%), incisors (6%), and canines (4%). Bone injury was diagnosed in 45% of the filled teeth. Statistical analysis showed that the probability of radiological detection of BP in filled teeth was 25 times higher than when root canals had not been treated. Periapical radiolucency associated with a well-filled canal was significantly less frequent than in cases of deficient fillings. The authors concluded that the prevalence of BP in all age groups in Belarus was higher than in other populations. The probability of BP increased significantly after endodontic treatment and was closely related to the quality of the filling.

To determine the prevalence of periapical lesion and endodontic treatment in a Japanese adult population, Tsuneishi et al. (2005) examined, through periapical composite charts of 672 patients (16232 teeth), the periapical status and the length of endodontic fillings. Of the total number of patients, 87% had filled teeth and 70% had at least one periapical radiolucent image. Regarding the total number of teeth, 21% were endodontically treated. Of these, 40% were associated with apical periodontitis. The higher prevalence of periapical lesions was associated with overfilling and mandibular incisors. Compared to the results of other countries in Europe and America, the

prevalence of filled teeth was higher in this study. However, the presence of periapical lesions associated with endodontic treatment was equivalent.

To investigate the prevalence of filled teeth and apical periodontitis in a Greek population, Georgopoulou et al. (2005) selected 320 complete radiographic charts of patients aged between 16 and 77 years. A total of 7664 teeth were evaluated and the frequency of filled teeth and periapical status were noted. Two observers evaluated the radiographs under standardized conditions. BP was defined as periapical radiolucent or enlargement of the periodontal ligament space twice as large and as normal thickness. Statistical evaluation of the differences in proportions between groups was performed using logistic regression models. A total of 1,040 (13.6%) teeth had radiographic signs of BP and 680 (9.2%) teeth were filled. Of the filled teeth, 408 (60.0%) had BP. There was no difference in the number of filled teeth in relation to gender and observed that the prevalence of filled teeth increased with age. Molars (13.1%) and premolars (11.9%) were significantly more filled than anterior teeth (5.8%) ($P < 0.001$). The prevalence of BP was also significantly higher ($P < 0.001$) in molars (23.9%) and premolars (14.0%) than in anterior teeth (9.4%). The researchers concluded that the prevalence of BP and the frequency of filled teeth affected by BP in this Greek population were higher than those found in many other European countries. The frequency of filled teeth was comparable with the results of other epidemiological studies.

In a study that investigated the prevalence of apical periodontitis and its association with endodontically treated teeth in residents of the city of São Luís, MA, Brazil, Terças et al. (2006) examined 200 complete periapical records over a period of 10 years. The Periapical Index was used to assess the health of the periapex. Age group, gender, tooth groups, location, and association with endodontic treatment were also analyzed. At least one case of AP was found in 135 patients (67.5%). Of the total of 5008 teeth examined, 296 had BP (5.9%) and 553 (11%) had filled canals. Of the 553 endodontically treated teeth, 235 (42.5%) were associated with BP. The chi-square test showed a strong correlation between BP and root canal treatment. The highest prevalence was in the 40-year-old age group. There was no association between BP and gender. The maxillary incisors were the most affected teeth. The authors concluded that the prevalence of apical periodontitis and teeth treated endodontically with AP was high and similar to the results of studies conducted in other countries.

The prevalence of apical periodontitis as well as the quality of endodontic treatment was verified in a Turkish population by Sunay et al. (2007). On panoramic radiographs, the periapical status of 8863 teeth from 375 patients was evaluated by two precalibrated observers. The presence of apical periodontitis, the prevalence and quality of root fillings were noted. The relationship between the quality of fillings and apical periodontitis was obtained by the analysis of the chi-square test. A total of 470 teeth (5.3%) underwent root canal treatment. Forty-seven percent of all individuals had

at least one endodontically treated tooth. Periapical radiolucency was visible in 4.2% of the teeth examined, and 53.5% of the teeth with endodontic treatment had apical periodontitis. Of these, 90.8% had deficient fillings, i.e., there was a statistically significant correlation (P<0.05) between the presence of lesions and the quality of the filling. Thus, the authors concluded that there is a need to improve the standards of endodontic treatment in the population studied.

Eckerbom, Flygare and Magnusson (2007), reassessed a Swedish population in order to assess the prevalence of endodontically treated teeth and apical periodontitis, as well as the quality of these fillings after 20 years. From an initial population of 200 participants (2825 teeth), 115 (2461 teeth) were re-examined using a complete radiographic clinical record, with conventional radiographs. The frequency of endodontically treated teeth increased significantly (P<0.05), from 13.9% at the first observation to 17.7% after 20 years. There was also a statistically significant increase (P <0.05) in patients with apical periodontitis from 3.3% to 6.8%. This increase occurred tenate in teeth with root canals treated as in teeth without endodontic treatment. There was an improvement in the quality of root fillings, but there was no improvement in the apical status in endodontically treated teeth. Thus, the authors concluded that both the number of teeth with the treated canal system as well as apical periodontitis increased during the time period covered by the study, and that despite an improvement in the quality of endodontic treatment, no improvement in the periapical health of treated teeth was found.

To assess the prevalence and risk factors of apical periodontitis in endodontically treated teeth in a population of Brazilian adults, Estrela et al. (2008b) analyzed 1372 periapical radiographs of endodontically treated teeth, observing the quality of the filling, the status of the coronary restoration and the presence of apical periodontitis. The data were statistically analyzed using odds ratio, confidence interval and chi-square test. The prevalence of BP in patients with adequate endodontic treatment was low (16.5%). This percentage dropped to 12.1% in cases with adequate filling and coronary restoration. Patients with adequate endodontic treatment and deficient coronary restoration had a BP prevalence of 27.9%. BP increased to 71.7% in patients with defective endodontic treatment and coronary restoration. When inadequate endodontic treatment was combined with good coronary restoration, the prevalence of BP was 61.8%. The authors also observed that the presence of intraradicular pins did not influence the prevalence of BP.

To examine the prevalence and technical quality of endodontic treatments and the periapical status of filled teeth in a subpopulation of Dakar, Touré et al. (2008) evaluated complete radiographic clinical records of 208 patients who sought the university's dental service. The occurrence and technical quality of the fillings were evaluated according to the apical extension of the root fillings and their density. Periapical status was assessed using the Periapical Index. When this was greater than 2, it indicated the presence of disease. The presence of coronary restorations and pins were also

observed. Statistical analysis was performed with the chi-square test. Of the 6234 teeth examined, 2.6% had filled canals. Apical periodontitis was diagnosed in 56.1% of the treated teeth. Only 17.7% of the fillings were technically acceptable and 26.2% of them were associated with a PAI> 2. In roots with inadequate treatments, 62.5% had an IAP> 2. Poor endodontic treatments were associated with a higher prevalence of periapical disease (P <0.001). Pins were observed in 18.9% of teeth with root canal treatment and of those, 66.2% were associated with a PAI> 2. Filled teeth without coronary sealing had significantly more periapical disease compared to those with stauriated teeth. The authors concluded that in this study the results indicated a low prevalence of endodontically treated teeth and periapical lesions and a high prevalence of inadequate treatments.

Through panoramic radiographs, a cross-sectional study that evaluated the prevalence of endodontically treated teeth in 1401 adult patients was developed by Hollanda et al. (2008). Three endodontists independently evaluated the radiographic images in the following items: presence of endodontic treatment, defined as partially or completely filled, regardless of whether the filling material ended at the radiographic apex or not, with or without an intraradicular retentor, or even in association with apical periodontitis. Odds ratio, logistic regression and the chi-square test were used for statistical analyses. Of a total of 29467 teeth evaluated, 6313 (21.4%) were treated endodonally. Endodontic treatment was more frequent in maxillary premolars and molars, while mandibular incisors had a lower prevalence. Most of the endodontically treated teeth were found in people aged 46 to 60 years (47.6%, p <0.001) and the authors observed that the prevalence increases with age. Women had a higher prevalence of filled teeth (61.9%) than male patients. Compared to studies from other countries, the authors found a higher prevalence of endodontically treated teeth in Brazil.

In order to verify the frequency and distribution of endodontically treated teeth, as well as the prevalence of apical periodontitis in an adult population in Turkey, Gulsahi et al. (2008) evaluated digital panoramic radiographs of 1,000 patients. Patients who are elderly, younger than 15 years of age, and those with fewer than nine teeth in their mouths were excluded. The coronal and periapical status of all teeth, except for the third molars, was evaluated according to the criteria proposed by De Moor et al. (2000). Statistical analysis was performed using the Rao and Scott test adjusted with the chi-square test for the comparison of binary cluster data. In total, 24433 teeth were examined. A total of 346 teeth (1.4%) had radiographic signs of apical periodontitis, and 812 were filled (3.3%). Of the endodontically treated teeth, 148 (18.2%) were associated with apical periodontitis. Apical periodontitis was associated with 198 teeth (0.8%) without endodontic treatment. The number of filled canal teeth in males was significantly lower than in females (P <0.001), but the presence of apical periodontitis in males was significantly higher than in females (P <0.05). The prevalence of apical periodontitis and the frequency of teeth with filled canals and with apical periodontitis were

lower than in similar populations in other countries. The number of teeth treated endodontically was comparable to that found in other epidemiological studies.

In a cross-sectional study, Tavares et al. (2009) determined the prevalence of apical periodontitis in 1035 endodontically treated teeth from 213 adult patients in France. The influence of the quality of the filling and coronary sealing on the periapex status was also investigated. Through the analysis of periapical radiographs, the teeth were classified according to the periapical index score as healthy or sick. The prevalence of apical periodontitis in treated root canals was 33%. Only 19% of the teeth had endodontic treatments classified as adequate. The success rate for cases with adequate endodontic treatment was 91%, which was significantly higher when compared to teeth with inadequate treatment (61%). Adequate restoration significantly decreased the prevalence of BP compared to teeth without adequate coronary sealing from 41% to 29%. The combination of adequate endodontic treatment and adequate restorations provided the highest success rate (93.5%). The authors concluded that the quality of endodontic treatment was the most important factor for success, although the quality of coronary restoration also influenced the outcome of treatment.

The objective of the study by Wu, Shemesh, and Wesselink (2009) was to identify, through a systematic review of the literature, the limitations of the publications that evaluated the outcome of endodontic treatment. Traditionally, periapical radiography has been used to evaluate the outcome of root canal treatment, considering the absence of periapical radiolucent a confirmation of a healthy periapex. However, a high percentage of cases confirmed as healthy by radiographs revealed apical periodontitis when evaluated by Cone Beam Computed Tomography and histopathological examinations. In clinical studies, two additional factors may have contributed to the overestimation of successful outcomes after root canal treatment: extractions and re-treatments were rarely recorded as failures; and the rate of preservation was many times less than 50%. The periapical index, frequently used to determine success, was based on radiological and histopathological findings in the periapical region of the maxillary incisors. The validity of PAI use for all tooth positions may be questionable, as the thickness of the cortical bone and the position of the root end in relation to the cortex may vary according to the position of the teeth. In conclusion, the severe limitations of clinical longitudinal studies may restrict the correct interpretation of root canal treatment results. Therefore, for the authors, the results of a root canal treatment should be re-evaluated in long-term longitudinal studies using CBCT and more rigorous evaluation criteria.

The current prevalence of apical periodontitis related to endodontically treated teeth in an Amsterdam population was compared by Peters et al. (2011) with a similar study developed in 1988.The lack of teeth, restorations, quality of endodontic treatment and periapical radiolucidity were evaluated. A total of 178 radiographs were evaluated and 4594 teeth were examined. Of these, 7% had increased apical periodontal ligament or periapical radiolucency and 4.8% had undergone

endodontic treatment. Radiographic signs of apical periodontitis were present in 2.5% of the teeth. Of these lesions, 45.7% were linked to endodontically treated teeth, which corresponds to 24.1% of endodontically treated teeth. Inadequate endodontic fillings were present in 55.8% of the cases. Apical radiolucent was significantly higher in these patients than in patients with adequate treatment. The authors concluded that the periapical status of this population did not improve over almost 20 years.

In order to assess the prevalence and distribution of apical periodontitis and endodontic treatment in a group of people from Jordan, Al-Omari, Hazza and Haddad (2011) analyzed 294 digital panoramic radiographs. The coronal and periapical status of all visible teeth were evaluated according to the criteria proposed by de Moor et al. It was observed that 83.7% of the patients had apical periodontitis and 63.3% had endodontically treated teeth. Of the 7,390 teeth evaluated, 11.6% had apical periodontitis and 5.7% were endodontically treated. A correlation was detected between apical periodontal lesions and endodontically treated teeth. Endodontic treatment was inadequate in 72.4% of cases, of which 87.0% had apical periodontitis. No difference was found in the number of teeth treated endodontically or the presence of periodontitis in relation to gender. The results of this study indicated that there is a relatively higher prevalence of apical periodontitis compared to those in many other countries, and that the percentage of endodontically treated teeth associated with apical periodontitis indicates a poor quality of endodontic treatment.

A possible association between the presence of apical periodontitis and the quality of endodontic treatment and coronary restoration over a 14-year time period was examined by Tolias et al. (2012). Panoramic radiographs of 1781 cadet freshmen, taken between the years 1995 and 2008, were included in this study. Periapical status was assessed using the Periapical Index. The chi-square test and logistic regression analysis were used to examine the association between apical disease and the quality of root filling and coronary restoration. 62.3% of the teeth analyzed showed BP. The number of teeth treated endodontically and the prevalence of BP were higher in radiographs obtained between 1995 and 2001 than between 2002 and 2008. Both the quality of the coronary restoration and the quality of the root filling (length and lateral seal) have been observed to be correlated with the presence of PA. The authors noted that the quality of endodontic treatment in Greek adults has improved over the years; and that both the quality of endodontic treatment and coronary restoration appear to affect the periapical status of treated teeth. The factor that probably most determined periapical health was the quality of the coronary restoration.

López-López et al. (2012) determined the prevalence of apical periodontitis and the frequency of endodontic treatment in a sample of 397 Spanish adults of both sexes. Digital panoramic radiographs were used and the periapical status was classified according to the periapical index. The results were analyzed using the chi-square test and logistic regression. Radiographic images

suggestive of BP in one or more teeth were found in 135 patients (34%). The prevalence of BP was significantly higher in males (42.3%) than in females (26.1%). At least one filled tooth was found in 233 patients (59%). Twenty-six percent of individuals with endodontically treated teeth had at least one periapical lesion associated with a treated tooth. The prevalence of BP increased with age. Patients with filled root canals demonstrated a higher prevalence of BP (42%) compared to patients without root canal treatment (23%). The authors concluded that both the prevalence of BP and the frequency of endodontic treatments are high among Spanish adults; and that patients with one or more endodontically treated teeth are more likely to have BP.

The aim of the study by Kalender et al. (2013) was to evaluate the prevalence of periapical lesions in teeth with root canals treated in a Turkish population and to investigate the influence of the quality of fillings and coronary restorations on the prevalence of periapical lesions. The sample for this cross-sectional study consisted of 1006 patients, where 2200 radiographs of endodontically treated teeth were evaluated. The teeth were grouped according to the radiographic quality of the root canal filling and the coronary restoration. Periapical status was assessed using the periapical index. Of the 2200 teeth with canals treated, 1364 (62%) had apical periodontitis, compared to 5.5% of the total sample. Of the teeth classified as adequately filled, 26.6% had an eryapical lesion, while those classified as unsatisfactory filling were present in 87.7% of the cases. A higher quanity of well-treated teeth than inadequately treated teeth was observed. The results demonstrated a high prevalence of periapical pathology with or without endodontic treatment. Therefore, the authors suggest the need for better education for dentists so that they can perform better root canal treatments and coronal restorations.

OBJECTIVES

GENERAL OBJECTIVE

To evaluate the prevalence of periradicular lesions and intraradicular retainers in anterior permanent teeth treated endodontically on periapical radiographs.

SPECIFIC OBJECTIVES

Check:

- the prevalence of periapical lesions in permanent anterior teeth;
- the prevalence of the dental element with periradicular lesions;
- the prevalence of intraradicular retainers in permanent anterior teeth;
- the prevalence of the dental element with an intraradicular retainer;
- the influence of the intraradicular retainer in relation to the prevalence of lesions;
- the influence of the filling limit in relation to the prevalence of periapical lesions;

- the influence of the homogeneity of the filling material in relation to the prevalence of periapical lesions;

METHODOLOGY

ETHICAL CONSIDERATIONS

This study was approved by the Research Ethics Committee (REC) of the University of Pernambuco (UPE), according to Resolution No. 196/96 of the National Health Council, through protocol No. 235,176.

The patients did not need to undergo radiation for radiographic taking exclusively for the purposes of the research in question.

TYPE OF STUDY

This is a retrospective, observational, cross-sectional study with a quantitative approach.

LOCATION OF THE STUDY

This research was developed in a private dental radiology clinic located in the city of Recife, Pernambuco, Brazil.

SAMPLE SIZE

A total of 1318 digital periapical radiographic records were selected, which corresponded to 11186 maxillary and mandibular anterior teeth from the clinic's archives, following specific criteria for sample selection.

SAMPLE SELECTION

A total of 7908 digital periapical radiographs belonging to patients of both sexes, performed in the radiology clinic in the last 2 years, were selected.

The data obtained during the clinical examination and anamnesis were not known, as well as gender, age, name, and indication for the examination. This sample was obtained through the selection of radiographs, following inclusion and exclusion criteria.

Inclusion Criteria

Digital periapical radiographs of upper and lower permanent anterior teeth, with complete rhizogenesis, obtained in the orthoradial position, were selected. The dental arches could not be completely edentulous, that is, the patient had to have at least one tooth in the upper or lower anterior region.

Exclusion Criteria

Radiographs suggesting teeth submitted to apicoectomy surgery, radiographs of the posterior teeth (premolars and molars), teeth with incomplete rhizogenesis, presence of impacted teeth, and total edentulous teeth in the anterior region were excluded.

ACQUISITION OF DIGITAL PERIAPICAL RADIOGRAPHS

Digital periapical radiographs were obtained using a periapical X-ray device, Timex-70 C (Gnatus, Ribeirão Preto, SP, Brazil), by radiology technicians using Hanshin radiographic positioners (JON, Brazil), to keep the phosphor plate parallel to the X-ray beam, reducing distortions due to horizontal and vertical malpositioning, standardizing the radiographic method. The kilovoltage (kVp) and milliamperage (mA) were 60 and 10, respectively. The time of exposure to X-rays varied according to the biotype, age of the patient and the anatomy of the region. Replacing the periapical film, the digital phosphor storage system with a 30 x 40 mm optical plate, Digora (Soredex Orion Corporation, Helsinki, Finland), was used, which captures the image indirectly, i.e., this plate, after being sensitized by X-rays, is read by a laser scanner and the information is transferred to a computer, resulting in the digital image.

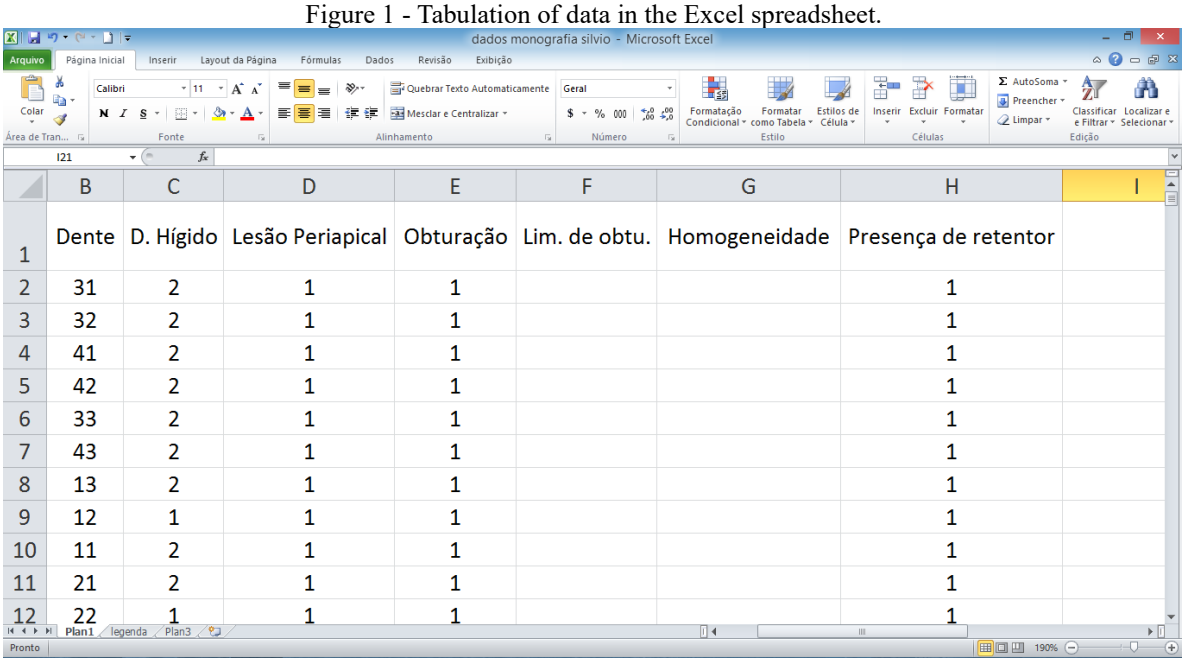
STORAGE OF RADIOGRAPHIC IMAGES

The images were stored in JPEG (Joint Photographic Experts Group) format with 150 dpi resolution. This format is commonly used to compress images as the degree of image reduction can be adjusted, which allows you to choose the storage size and your commitment to image quality.

RADIOGRAPHIC ANALYSIS

The images were viewed using the Paint program (Microsoft Windows, São Paulo, Brazil) version 6.0, on a 14-inch flat panel LCD monitor (Acer, Manaus, Brazil), with 1024 x 768 lines of resolution. Three evaluators, specialists in Endodontics, carried out the observation. After the first two evaluators examined the images, the conflicting results were confirmed by the third evaluator. To prevent a possible compromise of the analyses due to eye strain, the ambient light and the brightness of the monitor were reduced and the number of images was limited to 90 scans in sequence. The interpretation was conducted at different times of the day. Only manipulation of the brightness and contrast of the image was allowed. The notes were made in a Microsoft Excel spreadsheet, as shown in Figure 1.

Figure 1 - Tabulation of data in the Excel spreadsheet.



	B	C	D	E	F	G	H	I
1	Dente	D. Hígido	Lesão Periapical	Obturação	Lim. de obtu.	Homogeneidade	Presença de retentor	
2	31	2	1	1			1	
3	32	2	1	1			1	
4	41	2	1	1			1	
5	42	2	1	1			1	
6	33	2	1	1			1	
7	43	2	1	1			1	
8	13	2	1	1			1	
9	12	1	1	1			1	
10	11	2	1	1			1	
11	21	2	1	1			1	
12	22	1	1	1			1	

CRITERIA FOR RADIOGRAPHIC EVALUATION

Table 1 shows the criteria used to fill out the survey data sheet.

Treated root canals were those that contained radiopaque material in the pulp cavity or inside the root canal, disregarding those that suggested being part of the intraradicular retainer.

A radiolucent area connected to the root was classified as a periapical lesion. Slight enlargement of the periodontal ligament space with intact lamina dura or doubtful cases were recorded as absent pathology.

The longitudinal limit of the filling was considered underfilled when the end of the filled material was more than 2 mm away from the radiographic apex. Filling with adequate limit when this distance is between 2 and 0.5mm. Exactly, when this limit coincided with the apex. Overfilling occurred when the filling material exceeded the limit of the root vertex.

It was only observed whether the dental element had an intraradicular rentainer or not. The merits of type, quality and indication were not observed.

Table 1 – Criteria for radiographic evaluation

PERIAPICAL INJURY	1 – Absent 2 – Present
SHUTTER LIMIT	8 – Underfilled 9 – Satisfactory 10 – Exactly. 11 – Overfilled
HOMOGENEITY OF THE FILLING MATERIAL	1 - Failed 2 - No failure
PRESENCE OF INTRARADICULAR RETAINER	1 – Absent 2 – Present
TEETH	11 21 12 22 13 23 33 32 31 41 42 43

DATA TABULATION

Data were tabulated using a table from the SPSS (Statistical Package for the Social Sciences) to quantify periradicular lesions distributed by the number of dental elements and the presence or absence of an intraradicular retainer.

STATISTICAL ANALYSIS

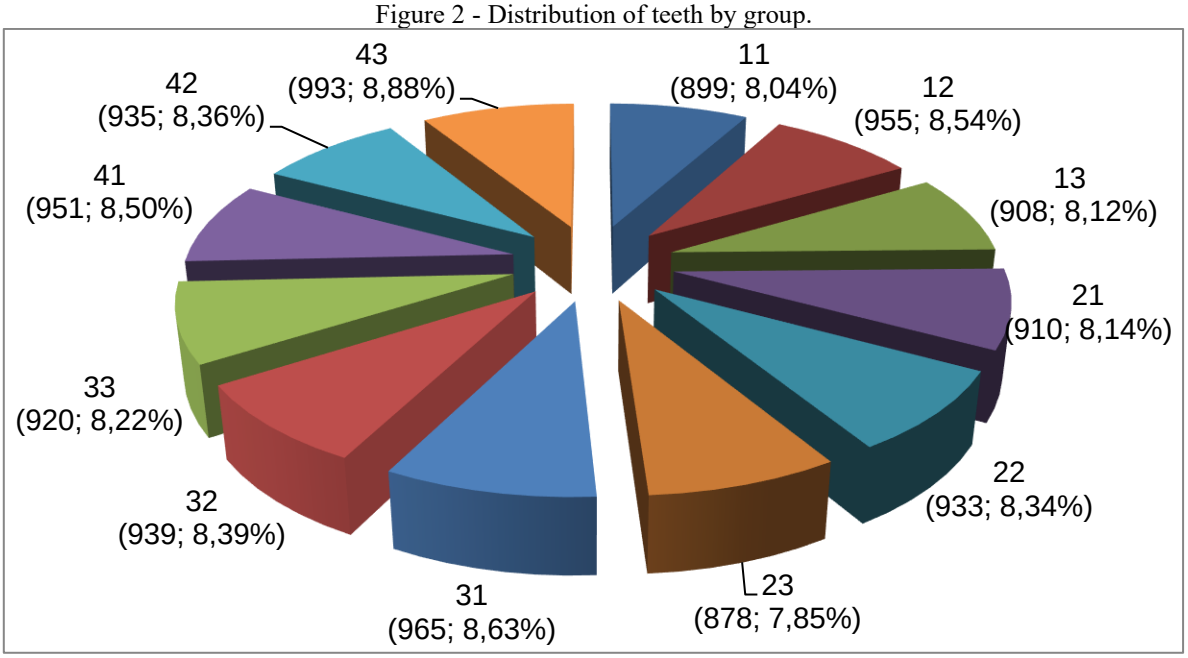
Absolute and percentage distributions and statistical measures were obtained: mean, median, standard deviation (descriptive statistical techniques) using Pearson's Chi-square statistical test (inferential statistics technique).

Statistical tests were performed with a margin of error of 5.0% using the SPSS software in version 15 for Windows.

RESULTS

After completing the analysis of the 1318 radiographic records, containing 6 radiographs each, a total of 11186 teeth were evaluated. Figure 2 shows the distribution, in absolute and percentage numbers, of the teeth in the corresponding groups.

Figure 2 - Distribution of teeth by group.



The distribution and presence of each dental group with and without periapical lesions, as well as the results of the entire sample, are shown in Table 2. Of the total number of teeth analyzed, 955 (8.5%) had apical periodontitis. The one with the highest percentage of lesions was the right upper lateral incisor, and the least susceptible was element 33, with less than 1% of the cases having BP. An interesting finding is the percentage of healthy teeth with periapical lesions: of the 7326 teeth with radiographically intact crowns, 101 teeth (1.4%) had periapical bone rarefaction.

Regarding endodontic treatment, 9.8% of the teeth had an obfilled canal. The right maxillary central incisor, with 19.4% of the cases filled, was the one with the highest prevalence. On the other hand, element 33 had the lowest prevalence, with only 2% of them treated, as can be seen in Table 3.

Table 2 - Distribution of the presence of apical periodontitis by group.

			Injury		
			Absent	**Present**	**Total**
Tooth	11	Quantity	776	123	899
		Percentage per tooth	86,3%	13,7%	100,0%
	12	**Quantity**	**800**	**155**	**955**
		Percentage per tooth	**83,8%**	**16,2%**	**100,0%**
	13	Quantity	796	112	908
		Percentage per tooth	87,7%	12,3%	100,0%
	21	**Quantity**	**798**	**112**	**910**
		Percentage per tooth	**87,7%**	**12,3%**	**100,0%**
	22	Quantity	798	135	933
		Percentage per tooth	85,5%	14,5%	100,0%
	23	**Quantity**	**802**	**76**	**878**
		Percentage per tooth	**91,3%**	**8,7%**	**100,0%**
	31	Quantity	910	55	965
		Percentage per tooth	94,3%	5,7%	100,0%
	32	**Quantity**	**906**	**33**	**939**
		Percentage per tooth	**96,5%**	**3,5%**	**100,0%**

	33	Quantity	912	8	920
		Percentage per tooth	99,1%	0,9%	100,0%
	41	**Quantity**	**886**	**65**	**951**
		Percentage per tooth	**93,2%**	**6,8%**	**100,0%**
	42	Quantity	896	39	935
		Percentage per tooth	95,8%	4,2%	100,0%
	43	**Quantity**	**951**	**42**	**993**
		Percentage per tooth	**95,8%**	**4,2%**	**100,0%**
Total		Quantity	10.231	955	11.186
		Percentage per tooth	91,5%	8,5%	100,0%

Table 3 – Distribution of endodontically treated teeth by group.

			Treated channel		
			No	**Yes**	**Total**
Tooth	11	Quantity	725	174	899
		Percentage per tooth	80,6%	19,4%	100,0%
	12	**Quantity**	**796**	**159**	**955**
		Percentage per tooth	**83,4%**	**16,6%**	**100,0%**
	13	Quantity	780	128	908
		Percentage per tooth	85,9%	14,1%	100,0%
	21	**Quantity**	**758**	**152**	**910**
		Percentage per tooth	**83,3%**	**16,7%**	**100,0%**
	22	Quantity	783	150	933
		Percentage per tooth	83,9%	16,1%	100,0%
	23	**Quantity**	**754**	**124**	**878**
		Percentage per tooth	**85,9%**	**14,1%**	**100,0%**
	31	Quantity	929	36	965
		Percentage per tooth	96,3%	3,7%	100,0%
	32	**Quantity**	**915**	**24**	**939**
		Percentage per tooth	**97,4%**	**2,6%**	**100,0%**
	33	Quantity	902	18	920
		Percentage per tooth	98,0%	2,0%	100,0%
	41	**Quantity**	**909**	**42**	**951**
		Percentage per tooth	**95,6%**	**4,4%**	**100,0%**
	42	Quantity	915	20	935
		Percentage per tooth	97,9%	2,1%	100,0%
	43	**Quantity**	**929**	**64**	**993**
		Percentage per tooth	**93,6%**	**6,4%**	**100,0%**
Total		Quantity	10.095	1.091	11.186
		Percentage per tooth	90,2%	9,8%	100,0%

Correlating the results of endodontically treated teeth with the presence of periapical pathology, we could observe that in 59% of the cases the lesion was associated with filled teeth, as shown in Table 4.

Table 4 – Relationship between endodontically treated teeth and periapical lesion

			Treated Channel		
			No	**Yes**	**Total**
Injury	Absent	Quantity Percentage per Injury	9.703 94,8%	528 5,2%	10.231 100,0%
	Present	Quantity Percentage per Injury	392 41,0%	563 59,0%	955 100,0%
Total		**Quantity Percentage per Injury**	**10.095 90,2%**	**1.091 9,8%**	**11.186 100,0%**

Table 5 shows the prevalence of intraradicular retainers in the anterior teeth (5%) and in each dental group. Element 21 had the highest percentage of pins, 9.9% of the left maxillary central incisors had a pin. Element 33 had the lowest prevalence of retainers, only 0.7% of the 914 lower left canines.

Table 5 – Prevalence of intraradicular retainers in permanent and group anterior teeth.

			Intraradicular Retainer		
			Absent	**Present**	**Total**
Tooth	11	Quantity	813	86	899
		Percentage per Tooth	90,4%	9,6%	100,0%
	12	**Quantity**	**869**	**86**	**955**
		Percentage per Tooth	**91,0%**	**9,0%**	**100,0%**
	13	Quantity	838	70	908
		Percentage per Tooth	92,3%	7,7%	100,0%
	21	**Quantity**	**820**	**90**	**910**
		Percentage per Tooth	**90,1%**	**9,9%**	**100,0%**
	22	Quantity	847	86	933
		Percentage per Tooth	90,8%	9,2%	100,0%
	23	**Quantity**	**812**	**66**	**878**
		Percentage per Tooth	**92,5%**	**7,5%**	**100,0%**
	31	Quantity	951	14	965
		Percentage per Tooth	98,5%	1,5%	100,0%
	32	**Quantity**	**923**	**16**	**939**
		Percentage per Tooth	**98,3%**	**1,7%**	**100,0%**
	33	Quantity	914	6	920
		Percentage per Tooth	99,3%	0,7%	100,0%
	41	**Quantity**	**931**	**20**	**951**
		Percentage per Tooth	**97,9%**	**2,1%**	**100,0%**
	42	Quantity	927	8	935
		Percentage per Tooth	99,1%	0,9%	100,0%
	43	**Quantity**	**977**	**16**	**993**
		Percentage per Tooth	**98,4%**	**1,6%**	**100,0%**
Total	Quantity		10.622	564	11.186
	Percentage per Tooth		95,0%	5,0%	100,0%

The relationship between periapical lesion and the presence of an intraradicular retainer, as shown in Table 6, revealed that 30.8% of the teeth with pins had radiolucency in the region of the root periapex.

Table 6 – Relationship between intraradicular retainer vs. periapical lesion.

			Pine		
			Absent	**Present**	**Total**
Periapical lesion	**Absent**	Quantity	9.961	270	10.231
		Percentage	97,4%	2,6%	100,0%
	Present	Quantity	661	294	955
		Percentage	69,2%	30,8%	100,0%
Total		Quantity	10.622	564	11.186
		Percentage	95,0%	5,0%	100,0%

To evaluate the quality of the root canal filling, two criteria were established: the longitudinal length of the filling and the homogeneity of the filling material observed on the radiograph. In less than half of all cases (44.5%), the filling was classified as satisfactory. The tooth in which the actual working length (CRT) limit was most often preserved, in percentage terms, was the left mandibular canine, with 66.7% of the cases of teeth filled in this situation. The least satisfactory results were elements 32 and 43, with only 25% of the cases satisfactorily filled, as shown in Table 7.

Regarding the homogeneity of the filling material, 55.1% of the cases presented radiographically adequate characteristics. The highest percentage of teeth with homogeneous filling was found in the right mandibular lateral incisors, while the one with the greatest complication to obtain a homogeneous obturator mass was element 43, with 56.3% of the cases classified as non-homogeneous filling. Table 8 shows these results.

The relationship between apical periodontitis and the quality of endodontic treatment. This relationship is shown in Tables 9 and 10, which relate the presence of periapical lesion with the longitudinal limit of the filling and with the homogeneity of the filling material, respectively.

Table 7 – Prevalence of the longitudinal limit of endodontic filling by group.

			Longitudinal limit of the blank				
			Sub-filled	**Satisfactory**	**Exact**	**Overfilled**	**Total**
Tooth	11	Quantity Percentage	70 40,2%	80 46,0%	14 8,0%	10 5,7%	174 100,0%
	12	Quantity Percentage	50 31,4%	79 49,7%	16 10,1%	14 8,8%	159 100,0%
	13	Quantity Percentage	66 51,6%	60 46,9%	2 1,6%	0 0,0%	128 100,0%
	21	Quantity Percentage	66 43,4%	64 42,1%	20 13,2%	2 1,3%	152 100,0%
	22	Quantity Percentage	60 40,0%	72 48,0%	12 8,0%	6 4,0%	150 100,0%
	23	Quantity Percentage	58 46,8%	58 46,8%	8 6,5%	0 0,0%	124 100,0%
	31	Quantity Percentage	10 27,8%	14 38,9%	12 33,3%	0 0,0%	36 100,0%
	32	Quantity Percentage	8 33,3%	6 25,0%	6 25,0%	4 16,7%	24 100,0%
	33	Quantity Percentage	4 22,2%	12 66,7%	2 11,1%	0 0,0%	18 100,0%
	41	Quantity Percentage	12 28,6%	12 28,6%	16 38,1%	2 4,8%	42 100,0%
	42	Quantity Percentage	6 30,0%	12 60,0%	0 0,0%	2 10,0%	20 100,0%
	43	Quantity Percentage	48 75,0%	16 25,0%	0 0,0%	0 0,0%	64 100,0%
Total		**Quantity Percentage**	**458 42,0%**	**485 44,5%**	**108 9,9%**	**40 3,7%**	**1.091 100,0%**

Table 8 – Prevalence of filling material homogeneity by group.

			Homogeneity		Total
			Flawed	Homogeneous	
Tooth	11	Quantity Percentage	82 47,1%	92 52,9%	174 100,0%
	12	Quantity Percentage	80 50,3%	79 49,7%	159 100,0%
	13	Quantity Percentage	62 48,4%	66 51,6%	128 100,0%
	21	Quantity Percentage	64 42,1%	88 57,9%	152 100,0%
	22	Quantity Percentage	68 45,3%	82 54,7%	150 100,0%
	23	Quantity Percentage	54 43,5%	70 56,5%	124 100,0%
	31	Quantity Percentage	14 38,9%	22 61,1%	36 100,0%
	32	Quantity Percentage	8 33,3%	16 66,7%	24 100,0%
	33	Quantity Percentage	8 44,4%	10 55,6%	18 100,0%
	41	Quantity Percentage	10 23,8%	32 76,2%	42 100,0%
	42	Quantity Percentage	4 20,0%	16 80,0%	20 100,0%
	43	Quantity Percentage	36 56,3%	28 43,8%	64 100,0%
Total		**Quantity Percentage**	**490 44,9%**	**601 55,1%**	**1.091 100,0%**

Underfilled teeth accounted for 42% of all root canal teeth. Of these, 44.8% had periapical lesions, while teeth with adequate filling (44.5% of the sample of teeth with endodontic treatment) were associated with periapical pathology in 36.1% of the cases. Of the teeth treated without the presence of lesions, the satisfactory canals showed 53.4% of treatment success.

Table 9 – Relationship between the longitudinal limit of the filling vs. periapical lesion.

			Longitudinal limit of the blank				Total
			Sub-filled	Satisfactory	Exact	Overfilled	
Injury	Absent	Amount Percentage	206 39,0%	282 53,4%	24 4,5%	16 3,0%	528 100,0%
	Present	Amount Percentage	252 44,8%	203 36,1%	84 14,9%	24 4,3%	563 100,0%
Total		**Amount Percentage**	**458 42,0%**	**485 44,5%**	**108 9,9%**	**40 3,7%**	**1.091 100,0%**

Table 10 - Relationship between homogeneity of filled material vs. periapical lesion.

			Homogeneity		Total
			Flawed	Homogeneous	
Injury	Absent	Quantity Percentage	174 33,0%	354 67,0%	528 100,0%
	Present	Quantity Percentage	316 56,1%	247 43,9%	563 100,0%
Total		**Quantity Percentage**	**490 44,9%**	**601 55,1%**	**1.091 100,0%**

Although found in only 10 cases, we observed the presence of intraradicular retainer in teeth without endodontic treatment, or with obturator material completely removed. Periapical pathology was present in all of them.

Of the 1091 cases with endodontically treated teeth, only 335 cases (30.7%) had a totally satisfactory endodontic treatment, i.e., with a longitudinal limit of the filling as measured by the CRT and with a radiographically homogeneous obturator mass.

DISCUSSION

As in several other studies, the radiographs analyzed in this study were obtained on the recommendation of another dental professional and not exclusively for research purposes, since frequent radiographic evaluation of healthy teeth with the sole purpose of detecting and monitoring the signs of apical periodontitis is not usually indicated for safety reasons in relation to the effects of radiation.

Traditionally, periapical radiography has been used to assess the outcome of root canal treatment with the absence of a periapical radiolucent being considered a confirmation of a healthy periapex, they are good diagnostic aids in endodontics, although they have limitations. Its accuracy

in detecting periapical bone defects is significantly higher than that of panoramic radiographs. However, no radiolucent inflammatory lesion can be reliably accurately diagnosed through clinical and radiographic examinations alone.

It should be emphasized, however, that it is not possible to detect from a simple x-ray whether an apical zone of bone loss is growing in size or healing. For this reason, cross-sectional studies such as this one are limited by the dynamic nature of periapical healing, and long-term follow-up studies may reflect better outcomes of endodontic interventions, since radiography is a static image of a dynamic process. Thus, classifying endodontic treatments as success or failure was used based on radiography and not on treatment time.

In previous studies, the prevalence of apical periodontitis ranged from 1.4% to 27% of all teeth in the sample. A similar result was found in this study, when the prevalence was 21.6%. In their study, Kabak and Abbott (2005) found that the prevalence of BP in incisors was 6% and in canines was 4%, for Georgopoulou et al. (2005), this prevalence was 9.4%. Compared to the present study, the maxillary central incisors had a much higher prevalence, ranging from 30.6% to 23.6%. The results of the mandibular incisors ranged from 25.0% to 16.7%.

The essential factor for endodontic success is the elimination of microorganisms from the root canal system through the association of procedures, i.e., cleaning, enlargement, modeling, use of intracanal antimicrobial medications, and quality of canal filling and coronary restoration. However, root canal cleaning and modeling cannot be evaluated by periapical radiography because a two-dimensional image does not provide complete information about the quality of the treatment performed. For this reason, this study evaluated only the longitudinal limit and the homogeneity of the filling.

"The compaction of the filling material is an important factor for the sealing of the canal filling and, consequently, for the effectiveness of the treatment" (FRACASSI et al. 2013), "since well-performed instrumentation and filling can prevent the infiltration of bacteria and their products to the periapex" (RICUCCI, GRÖNDAHL, BERGENHOLTZ, 2000). "The choice of a particular length of root canal instrumentation and filling is clinically controversial and complicated, probably as a result of the limitations of periapical radiography" (MOURA et al. 2009).

The presence of periapical lesion (21.6%); in relation to the filling limit for the majority, it was below (62.5%), followed by CDC (21.6%); in a little less than half (45.8%) there was a failure in the homogeneity of the restorative material. The presence of retainer space was verified in 35.8% of the sample and coronary sealing was verified in a little more than half (51.6%).

Poorly filled root canals do not necessarily indicate failure, but they can facilitate bacterial invasion and its by-products into the root canals, which in turn can lead to diseases causing treatment failure (LOFTUS, KEATING, MCCARTAN, 2005). Apical periodontitis is found less frequently

when the quality of endodontic treatment is good (ECKERBOM, FLYGARE, MAGNUSSON, 2007). In this study, we found that 49% of the teeth in which the filling was radiographically homogeneous and 17% of the cases of teeth treated at the CRT limit had apical periodontitis. The values increased when the tooth was underfilled or the obturator mass was not homogeneous.

"There are no statistical differences in relation to the prevalence of apical periodontitis related to endodontic treatment when it was performed by a general dentist or by an endodontist" (DUGAS et al. 2003).

For Segura-Egea (2004), Tavares et al. (2009), Peters et al. (2011), adequate filling has a more significant impact on the outcome of endodontic treatment than the quality of coronary restoration.

The presence of intraradicular pins did not influence the prevalence of BP in the study by Boucher et al. (2002), 26% of the filled canals had pins and of these 29% had apical periodontitis. In 2008, Touré et al. observed that 18.9% of the teeth treated endodontically had intraradicular retainer and that 66.2% of these were associated with BP. In our data, 18.6% of the teeth with pins had an associated lesion, a different result when compared to the 24.3% of lesions associated with teeth with inhomogeneous fillings, and the 32.4% of the cases in which the filling was performed at the exact limit of the canal. Once again, it was observed that the quality of the treatment was the most important factor in the success rate of the treatment.

CONCLUSIONS

With the analysis of all the results obtained through the methodology used and after discussing them, it is possible to conclude that:

- Periapical lesions are commonly found on digital periapical radiographs;
- The anterior permanent teeth of the maxilla are most commonly affected by apical periodontitis;
- The prevalence of periapical lesions in the permanent anterior teeth is low when compared to the other countries mentioned in the other studies;
- The quality of endodontic treatments performed in the city of Recife needs to improve;
- The quality of the canal filling was the main factor for causes of BP associated with endodontically treated teeth;
- Half of the teeth submitted to endodontic treatment required an intraradicular pin;
- The presence of a retainer does not influence the prevalence of BP in endodontically treated teeth.

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