

ORIGINAL RESEARCH

Periapical Status and Quality of Root Canal Obturation in Elderly Population: A Systematic Review

¹Fabrcio Rutz da Silva, ²Eduardo Hebling, ³Valéria Silva Cândido Brizon, ⁴Antônio Carlos Pereira
⁵Edna Zakrzewski Padilha, ⁶Raisa Hintz

ABSTRACT

The aim of this study was to investigate the relationship between root fillings and the presence of apical periodontitis in studies with samples containing elderly patients. The data were obtained by means of a systematic review of studies that evaluated the quality of root fillings and their relationship with periapical health. 1,376 potentially relevant articles were selected, of which 667 were repeated and 16 were duplicates. 693 abstracts were analyzed, with 608 of these being excluded and 85 selected for reading in full. Fourteen (14) articles were included, totaling data of 135,566 teeth. Of these, 13,704 (10.1%) had endodontic fillings, with 6,455 (47.1%) being considered adequate and 7,249 (52.9%) inadequate. Among the teeth with apical periodontitis, 2,084 (32.3%) had adequate endodontic fillings and 3,749 (51.6%) had inadequate fillings. There was a significant correlation between the quality of endodontic fillings considered adequate and lower frequency of apical periodontitis in elderly patients.

Keywords: Apical periodontitis, Elderly, Endodontics, Epidemiology, Root canal obturation.

How to cite this article: da Silva FR, Hebling E, Brizon VSC, Pereira AC, Padilha EZ, Hintz R. Periapical Status and Quality of Root Canal Obturation in Elderly Population: A Systematic Review. *J Orofac Res* 2014;4(2):81-89.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The quality of endodontic treatment and periapical health are important parameters in the prognosis of future dental

treatment needs.¹ The increase in longevity of the world population and the success of preventive dentistry will lead to a growth of the expectation of maintenance of dentition in the elderly patients. This fact may result in an increase of the endodontic treatment needs in this population.² The relationship between the quality of root fillings (RF) and the frequency of periapical lesions had been demonstrated.^{3,4}

Apical periodontitis (AP) is a local inflammatory response to infection of endodontic origin.⁵ Dental pulp infection generally occurs as a sequel to dental caries, trauma, operative procedures or in situations in which bacteria and their toxins are able to penetrate into the intimate areas of the pulp tissue.⁶ Failure of root canal treatment is generally believed to be caused by inadequate treatment procedures and ineffective control or elimination of bacterial infection.⁷

The prevalence of AP has also been related to the increase in age,⁸ suggesting that this relationship would be more evident due to the increase in the number of dentate elderly persons.⁹ Little epidemiological data on the endodontic and periapical status of the elderly have been gathered. These endodontic parameters are important to predict tooth survival and the future need for dental treatment.³

Outcomes from cross-sectional epidemiological surveys showed evidences that older subjects have a lower number of remaining teeth and higher ratio of RF and AP in their teeth compared with younger adults.¹⁰ Longitudinal studies also confirmed these results demonstrated that, on average, the number of teeth decreased with age, but the number of root filled teeth increased in studied elderly populations.^{11,12} However, contrary to these cross-sectional and longitudinal studies, other longitudinal study in elderly women with follow-up of 24 years showed that the prevalence of AP did not increase with age, probably as a result of root canal treatment and extractions. This study also showed that the frequency of RF teeth and teeth with AP decreased over time for comparable age groups.¹³

In different population, several epidemiological studies have reported high frequency of AP associated with RF teeth, especially those related with inadequate endodontic treatments.¹⁻¹⁰ However, the outcomes of these cross-sectional studies considered samples from different age. Cohort studies containing exclusively elderly patients are scant.

^{1,3,5}PhD Student, ^{2,4}Associate Professor, ⁶Master of Science

¹Department of Restorative Dentistry, Piracicaba Dental School, University of Campinas (UNICAMP), São Paulo, Brazil

²⁻⁴Department of Community Dentistry, Piracicaba Dental School, University of Campinas (UNICAMP), São Paulo, Brazil

⁵Department of Morphology, Piracicaba Dental School University of Campinas, (UNICAMP), São Paulo, Brazil

⁶Department of Dentistry, Pontifical Catholic University of Parana, Parana, Brazil

Corresponding Author: Eduardo Hebling, Associate Professor, Department of Community Dentistry, Piracicaba Dental School, University of Campinas, (UNICAMP), São Paulo, Brazil, e-mail: hebling@fop.unicamp.br

Considering the importance of epidemiological studies, the aim of this study was to investigate the relationship between root fillings and the presence of apical periodontitis in studies with samples containing elderly patients, by means of a systematic review of the literature.

MATERIALS AND METHODS

The selection of articles used in the study was performed in two stages: (I) abstracts and titles were selected; and (II) the complete texts of the selected titles were obtained and read to determine the set of the final sample. To identify studies included in or considered for this revision, a search strategy was developed for the electronic databases, using keywords from a list of Descriptors in Health Sciences (DeCS) and in Medical Subject Headings (MeSH), and their combinations. The following keywords were used: periapical periodontitis, periapical abscess, periapical granuloma, radicular cyst, endodontic treatment; pulpectomy, root canal filling, root canal obturation and root canal therapy.

The inclusion criteria for the selection of titles were: (a) studies in humans, (b) samples including individuals aged 60 years or older, (c) definition of clear and well established criteria for evaluating the quality of root fillings, (d) definition of clear and well established criteria for evaluating periapical health, (e) establishment of the relationship between the quality of endodontic treatments and presence of periapical lesions, (f) articles published in English between January 01, 1986 and July 01, 2013 in the PubMed and ISI Web of Knowledge databases (Flow Chart 1).

The initial search was performed by two independent researchers, who located and selected the articles. The selection of studies based on the title and abstract was done independently and in duplicate. After reading the title of the article, the researchers either selected it or not for the systematic review. If the article did not meet the inclusion criteria, it was excluded by the title. If the title of the article did not provide sufficient information for selecting or excluding it, the researchers had to read the abstract and opt between selecting or excluding the article by the abstract. If there were repetition of one and the same study, its copy would be excluded. In addition, the researchers observed cases in which the same article appeared more than once in the same database, and classified it as repeated. This procedure was followed in all the databases.

After a systematic search and selection of the article, a first meeting of consensus was held to clear doubts and disagreements between the researchers.

The next stage was to seek, and read the selected articles in full, and then evaluate whether they would be included in the sample. Each researcher filled out a standardized form in the Excel™ (Microsoft Corporation, Redmond, WA, USA)

software, with the following data about the article: author, year and country in which the study was conducted, type of study, type of radiographic technique used in the study, number of participating individuals; number of teeth evaluated, gender of the sample, frequency of AP in teeth with adequate and inadequate RF, frequency of adequate RF with AP and inadequate RF without AP. The lists of references of the selected articles were also checked independently by the two researchers, who proceeded with the search to identify studies with potential relevance not found in the electronic search.

A second consensus meeting was held between the researchers to clear-up doubts and disagreements among the titles read, and filling out of the formula. The studies that met the established criteria were considered in the final analysis. Possible disagreements during the entire process were resolved by means of consensus.

In addition to the electronic databases searched, the lists of references of literature reviews were revised, but no additional studies were included. Efforts were made to try and find studies with elderly persons, which related the quality of the endodontic treatments and presence of AP.

The quality of the articles was evaluated by means of the quality assessment tool for quantitative studies¹⁴ by two independent evaluators and disagreements were resolved by consensus. This validated tool was developed for the evaluation of systematic reviews on health promotion and public health interventions, in addition to randomized clinical trials, quasi-experimental studies and uncontrolled studies.¹⁵ It evaluates the articles in six different parameters: biases, study designs, confounding factors, blinding, methods of sample collection, and sample losses. The final score 1 classifies the study as strong; 2, as moderate and 3, as weak.^{14,15}

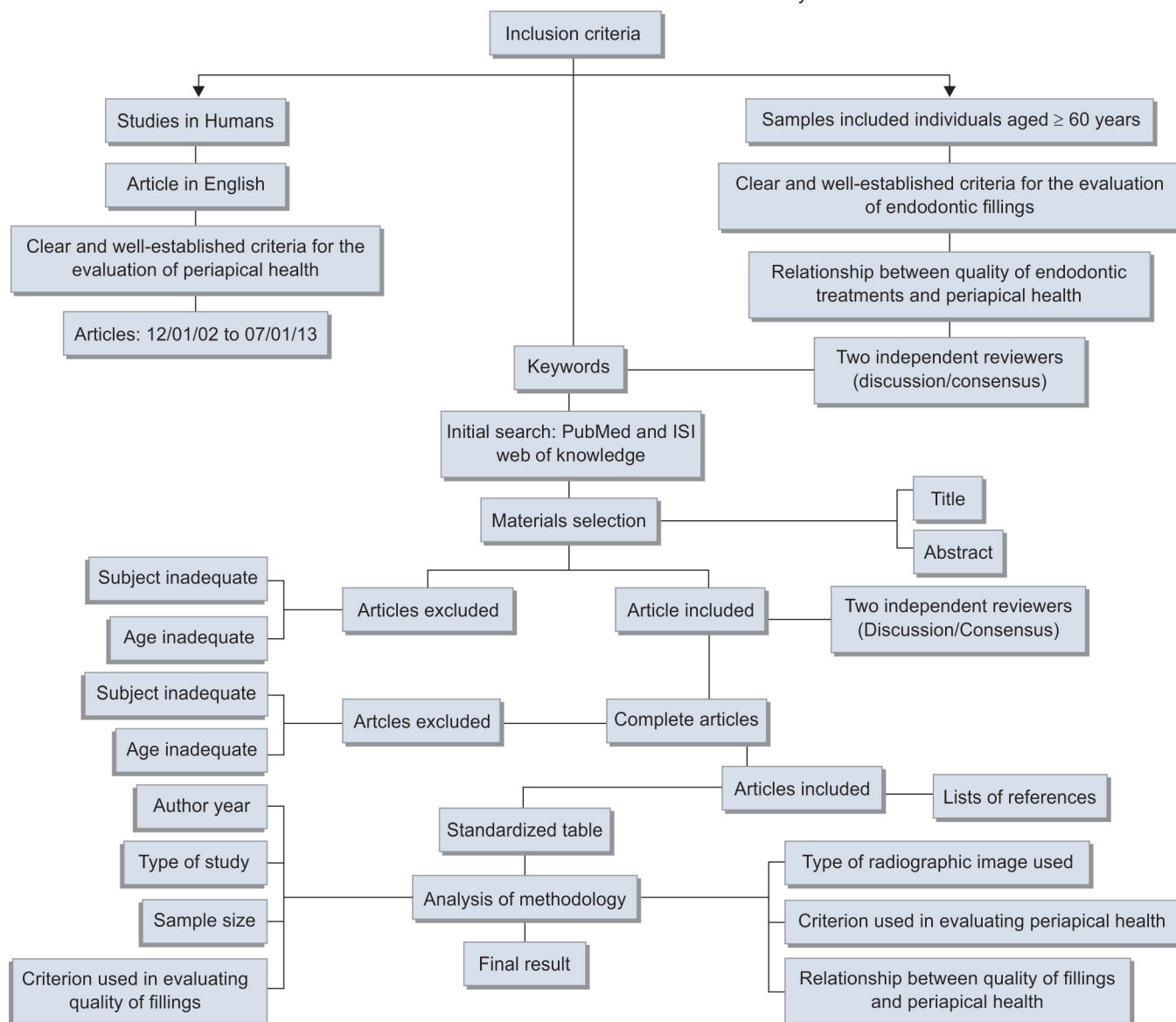
Raw data were entered into Excel™ software (Microsoft Corporation, Redmond, WA, USA). The analyses were carried out in an SAS System™ (SAS Institute Inc, Cary, North Caroline, USA). The frequency of root-filled teeth was calculated, and the periapical status on all teeth and on the treated teeth was assessed. Chi-square and independent t-tests ($\alpha = 5\%$) were used to examine associations between both prevalence and frequency of AP in RF teeth and the standard of the root filling.

RESULTS

Of a total of 1,376 potentially relevant records found in the two databases, 667 were repeated and 16 were duplicates. Therefore, the abstracts of 693 were read. A total of 608 references were excluded based on the titles and/or abstracts; 85 were selected for analysis of the full text, of which 14 were selected for inclusion in this systematic review (Flow Chart 2).

Among the articles included, there was diversity of countries who have worked with the theme proposed in

Flow Chart 1: The inclusion criteria of this study



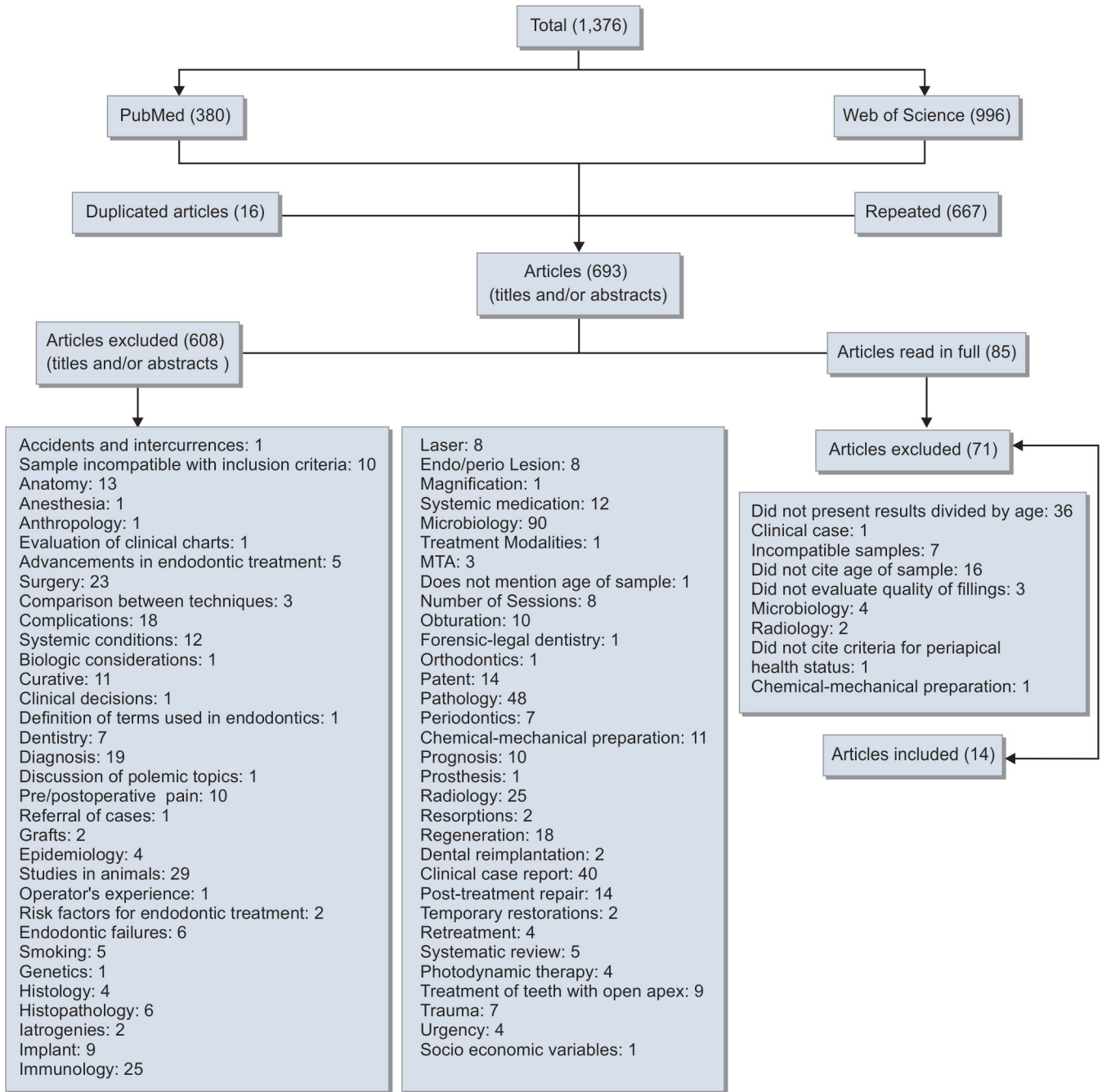
this review: two were conducted in Denmark,^{9,16} two in France,^{17,18} two in Spain,^{1,19} two in Turkey,^{20,21} one in Ireland,²² one in Japan,²³ one in Brazil,²⁴ one in Senegal,²⁵ one in Kosovo,²⁶ and one in Croatia²⁷ (Tables 1 and 3).

In the evaluation of the quality of RF, various criteria were used in the selected studies: three studies used the distance of the endodontic filling from the root apex,^{16,21,23} three studies used the filling density and its distance from the apex,^{17,18,25} three studies defined the parameter as being the presence of filling material in the root canal^{1,9,19} four studies preferred criteria proposed by other authors^{20,22,26,27} and in one article the authors created their own guidelines²⁴ (Table 1).

In the evaluation of the periapical status, represented by the presence of AP, the majority of the studies included in this present review^{1,9,16-19,21-23,25-27} used the periapical index (PAI) system proposed by Ørstavik et al²⁸ (Table 1).

The articles selected for this study contained data on a total of 135,566 teeth. Of these, 13,704 (10.1%) had RF, with 6,455 (47.1%) of these fillings being considered adequate and 7,249 (52.9%) inadequate. Among the adequate root fillings, 2,084 (32.3%) were diagnosed with AP. Among the inadequate root fillings, 3,740 (51.6%) had AP. The frequency of AP ranged from 0.5²² to 13.8%.¹⁷ The frequency of teeth with RF ranged from 1.5²¹ to 20.5%.²³ In comparison with the total number of teeth with RF considered adequate, the percentage ranged from 26.5¹⁶ to 56.9%.²⁴ Whereas, for those teeth with RF classified as inadequate, the range was from 43.1²⁴ to 73.5%.¹⁶ The ratio between quality of RF teeth and presence of AP showed results with great amplitude. When the frequency of AP in adequate RF teeth was evaluated in comparison with the total number of RF teeth, the range was from 0.1²⁶ to 41.6%.²³ In inadequate RF teeth with AP, this frequency ranged from 16.8²⁴ to 58.5%.¹⁶

Flow Chart 2: The systematic review



Evaluation of the quality of the articles by means of the quality assessment tool for quantitative studies^{14,15} had 100% consensus for each item between the evaluators. The evaluation showed the following results (Table 2): three studies^{17,19,24} obtained the final (score 1), thus being classified as strong; four articles^{9,16,23,25} were classified as moderate (score 2); and the majority of the articles included^{1,18,20-22,26,27} were classified as weak (score 3).

DISCUSSION

The result of the evaluation of the articles included by means of the quality assessment tool for quantitative studies^{14,15} reflected the difficulty authors have in controlling the

multiple variables present in the researches. In none of the 14 articles included in this systematic review was there blinding on the part of the evaluators and participants included in the sample, and it was for this reason that none of these articles was considered strong for this criterion (Table 2). When analyzing these results, we must take into consideration that the researchers could not have been blinded, because the researchers depended on the evaluation of radiographic images and, for this purpose, these researchers were previously calibrated, and therefore knew the objective of the research. The nonblinding of individuals participating in the researches did not influence the results of the studies, because the evaluation of the quality of fillings and periapical

Table 1: Criteria used to assess the root filling and apical periodontitis status

Authors	Country	RF criteria	AP criteria
Boucher et al (2002) ¹⁷	France	Filling density and its distance from the apex	PAI = 1: healthy; PAI ≤2: AP
Estrela et al (2008) ²⁴	Brazil	Criteria proposed by the authors themselves	Criteria proposed by authors themselves
Jiménez-Pinzón et al (2004) ¹⁹	Spain	Presence of filling material in the root canal	PAI = 1: healthy; PAI ≤2: AP
Kamberi et al (2010) ²⁶	Kosovo	Criteria proposed by other authors	PAI = 1: healthy; PAI ≤2: AP
Kirkevang et al (2000) ¹⁶	Denmark	Filling distance from the apex	PAI = 1: healthy; PAI ≤3: AP
Kirkevang et al (2001) ⁹	Denmark	Presence of filling material in the root canal	PAI = 1: healthy; PAI ≤3: AP
Loftus et al (2005) ²²	Ireland	Criteria proposed by other authors	PAI = 1: healthy; PAI ≤3: AP
López-López et al (2012) ¹	Spain	Presence of filling material in the root canal	PAI = 1: healthy; PAI ≤2: AP
Lupi-Pegurier et al (2002) ¹⁸	France	Filling density and its distance from the apex	Criteria proposed by authors themselves
Matijević et al (2011) ²⁷	Croatia	Criteria proposed by other authors	PAI = 1: healthy; PAI ≤2: AP
Özbas et al (2011) ²¹	Turkey	Filling distance from the apex	PAI = 1: healthy; PAI ≤2: AP
Sunay et al (2007) ²⁰	Turkey	Criteria proposed by other authors	Criteria proposed by authors themselves
Touré et al (2008) ²⁵	Senegal	Filling density and its distance from the apex	PAI = 1: healthy; PAI ≤2: AP
Tsuneishi et al (2005) ²³	Japan	Filling distance from the apex	PAI = 1: healthy; PAI ≤2: AP

PAI: Periapical index system²⁸

Table 2: Evaluation of articles using the quality assessment tool for quantitative studies

Items of quality scale	Articles													
	Boucher et al (2002) ¹⁷	Estrela et al (2008) ²⁴	Jiménez-Pinzón et al (2004) ¹⁹	Kamberi et al (2010) ²⁶	Kirkevang et al (2000) ¹⁶	Kirkevang et al (2001) ⁹	Loftus et al (2005) ²²	López-López et al (2012) ¹	Lupi-Pegurier et al (2002) ¹⁸	Matijević et al (2011) ²⁷	Özbas et al (2011) ²¹	Sunay et al (2007) ²⁰	Touré et al (2008) ²⁵	Tsuneishi et al (2005) ²³
Bias	2	1	2	3	2	1	1	2	3	3	2	3	3	2
Design of study	1	1	1	1	1	1	3	3	3	1	3	1	1	3
Confounding factors	1	1	2	3	1	1	1	1	3	3	3	2	1	1
Blinding	2	2	2	2	3	3	3	3	2	2	3	3	2	2
Collection methods	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Losses	1	2	1	1	2	2	1	1	1	2	1	1	1	1
Final score (consensus)	1	1	1	3	2	2	3	3	3	3	3	3	2	2

condition were performed by means of radiographic image analysis and not symptoms related by the participating patient him/herself, which could generate biases. On the other hand, the data collection method was considered strong for all the researches included in this review, which characterizes the attention of the authors in the descriptions of the methodologies used in their researches.

Considering all the six parameters proposed by the quality assessment tool for quantitative studies, only three studies were classified as strong.^{17,19,24} The research conducted by Boucher et al¹⁷ obtained moderate classification for the criteria 'biases' and 'blinding', and was classified strong in the other four parameters. The moderate quantification in the criterion 'biases' was attributed because the study used a convenience sample, which would not represent the conditions of the target population of the study. Estrela et al²⁴

also had two parameters evaluated as moderate ('blinding' and 'sample losses'), and the other four were classified as strong. This occurred because the authors did not cite any sample loss, which is understandable, seeing that periapical radiographs of endodontic treatments performed in the post-graduation clinic of endodontics were used. Therefore, there were no losses from the sample. Whereas, the study of Jiménez-Pinzón et al¹⁹ had three criteria evaluated as moderate ('biases', 'confounding factors', and 'blinding'), and the other three were considered strong. In this study, the authors also used a convenience sample, therefore, nonrepresentative of the conditions of the target population of the study. This fact was responsible for the 'moderate' classification obtained in the requisite of 'biases'. For the criterium 'confounding factors', the moderate classification was as a result of the mentioned article being limited to citing

Table 3: Comparison of the frequency of apical periodontitis (AP) and root fillings (RF) between the studies selected for this review that included elderly in the sample*

Author (s) (reference) (country/year)	Study/ RX	Sample			Frequency of AP n (%)			Frequency of teeth with RF n (%)			Frequency of RF status n (%)			Frequency of RF in teeth with AP n (%)		
		Subjects (teeth)	Age (mean)	Gender	Subjects with ≥ 1 teeth	In all teeth	Untreated teeth	Subjects with ≥ 1 teeth	In all teeth	Teeth with adequate RF	In all teeth	Teeth with inadequate RF	In all teeth	Teeth with adequate RF	In all teeth	Teeth with inadequate RF
Boucher et al ¹⁷ (France, 2002)	CS/ OPG	208 (5,312)	18-70+ (NRC)	M/F	NRC (NRC)	735 (13.8)	553 (54.2)	182 (3.4)	NRC (NRC)	1,021 (19.2)	NRC (NRC)	NRC (NRC)	553 (10.4)	NRC (NRC)	NRC (NRC)	NRC (NRC)
Estrela et al ²⁴ (Brazil, 2008)	CS/IP	NRC (NRC)	18-60 (NRC)	M/F	NRC (NRC)	NRC (NRC)	521 (38.0)	NRC (NRC)	NRC (NRC)	1,372 (NRC)	781 (56.9)	781 (43.1)	521 (NRC)	129 (9.4)	129 (NRC)	392 (28.6)
Jiménez-Pinzón et al ¹⁹ (Spain, 2004)	CS/IP	180 (4,453)	18-60+ (37)	M/F	110 (61.1)	186 (4.2)	60 (64.5)	126 (2.8)	73 (40.6)	93 (2.1)	NRC (NRC)	NRC (NRC)	60 (1.4)	NRC (NRC)	NRC (NRC)	NRC (NRC)
Kamberi et al ²⁶ (Kosovo, 2010)	CSET/ OPG	193 (4,131)	18-60+ (35)	M/F	NRC (NRC)	509 (12.3)	44 (46.3)	465 (11.2)	NRC (NRC)	773 (2.3)	29 (30.5)	29 (1.6)	44 (1.1)	6 (0.1)	6 (0.1)	38 (40.0)
Kirkevang et al ¹⁶ (Denmark, 2000)	CSET/IP	614 (NRC)	20-60+ (NRC)	M/F	NRC (NRC)	NRC (NRC)	404 (52.3)	NRC (NRC)	NRC (NRC)	773 (NRC)	205 (26.5)	205 (73.5)	NRC (NRC)	72 (9.3)	NRC (NRC)	332 (58.5)
Kirkevang et al ⁹ (Denmark, 2001)	CS/IP	614 (15,984)	20-60+ (NRC)	M/F	260 (42.3)	538 (3.4)	404 (52.3)	134 (0.8)	319 (52.0)	773 (4.8)	NRC (NRC)	NRC (NRC)	404 (2.5)	NRC (NRC)	NRC (NRC)	NRC (NRC)
Loftus et al ²² (Ireland, 2005)	CS/RP	302 (7,424)	16-98 (NRC)	M/F	100 (33.1)	38 (0.5)	38 (25.0)	114 (1.5)	96 (31.8)	152 (2.0)	72 (47.4)	72 (1.1)	38 (0.5)	10 (6.6)	10 (0.4)	28 (18.4)
López-López et al ¹ (Spain, 2012)	CS/RP	397 (9,390)	18-70+ (52)	M/F	135 (34.0)	259 (2.8)	144 (23.8)	115 (1.3)	233 (58.7)	604 (6.4)	NRC (NRC)	NRC (NRC)	144 (1.5)	NRC (NRC)	NRC (NRC)	NRC (NRC)
Lupi-Pegurier et al ¹⁸ (France, 2002)	CS/RP	344 (7,561)	20-60+ (NRC)	M/F	NRC (NRC)	553 (7.3)	450 (31.5)	103 (1.7)	NRC (NRC)	1,429 (18.9)	446 (5.9)	446 (68.8)	450 (5.9)	NRC (NRC)	NRC (NRC)	NRC (NRC)
Matijević et al ²⁷ (Croatia, 2011)	CS/RP	1,462 (38,440)	15-60+ (NRC)	M/F	NRC (NRC)	3,251 (8.5)	1,772 (54.0)	1,479 (3.9)	1,125 (77.0)	3,279 (8.5)	NRC (NRC)	NRC (NRC)	1,772 (4.6)	NRC (NRC)	NRC (NRC)	NRC (NRC)
Sunay et al ²⁰ (Turkey, 2007)	CS/ OPG	375 (8,863)	16-82 (NRC)	M/F	NRC (NRC)	374 (4.2)	240 (2.8)	134 (1.5)	176 (47.0)	449 (5.2)	188 (41.9)	188 (2.9)	209 (2.4)	22 (4.9)	22 (2.5)	218 (48.6)
Özbas et al ²¹ (Senegal, 2011)	CS/IP	438 (11,542)	10-79 (NRC)	M/F	NRC (NRC)	189 (1.6)	68 (37.9)	121 (1.0)	NRC (NRC)	179 (1.5)	NRC (NRC)	NRC (NRC)	68 (0.59)	15 (8.4)	15 (0.5)	53 (29.6)
Touré et al ²⁵ (Senegal, 2008)	CS/IP	208 (6,234)	18-70+ (32)	M/F	124 (59.6)	290 (4.7)	93 (56.4)	197 (3.2)	74 (35.6)	165 (2.7)	NRC (NRC)	NRC (NRC)	93 (1.5)	NRC (NRC)	NRC (NRC)	NRC (NRC)
Tsuneishi et al ²³ (Japan, 2005)	CS/IP	672 (16,232)	20-89 (51)	M/F	469 (69.8)	1,522 (9.4)	1,329 (40.0)	193 (1.2)	581 (86.5)	3,320 (20.5)	1,857 (11.4)	1,463 (9.0)	3,320 (20.5)	773 (4.7)	556 (3.4)	566 (16.8)

*Data calculated by the present authors from information published in the articles; NRC: Not reported or calculable from information presented in the article; n: number of teeth or subjects; M: Male; F: Female; CS: Cross-sectional study; P: Periapical radiographic survey; OPG: Orthopantomogram survey

only some information about the composition of the sample, such as, the percentage of men and women, and division by ages. Other important variables in characterization of the sample could have been included, such as, the general health conditions and the age at which endodontic treatment was performed.

Pak et al²⁹ observed that the frequency of pulp diseases could be higher than that presented by a large portion of the studies. According to these authors, not all pulp diseases produce evident periapical alterations, and not every lesion of endodontic origin is located at the apex of the tooth, and initial radiographic alterations may not be detected. According Goodis et al,³⁰ in elderly patients, this becomes more evident, because due to the histological and physiological alterations, a loss of sensitivity of the tooth may occur, leading to the patient not seeking the dentist.

Furthermore, Pak et al²⁹ considered that the use of panoramic radiographs instead of periapical radiographs may contribute even further to biases. Other authors were in agreement with this affirmation.^{3,29} Moreover, Estrela et al³¹ affirmed that even the use of intraoral radiographs may not be effective for the diagnosis of small periapical lesions. A high percentage of cases classified as healthy by means of periapical radiographs were, however, shown to have AP when examined histologically and by cone beam computed tomography (CBCT).³¹ Thus, some researchers have suggested the use of CBCT when conducting future studies, thereby minimizing the technical limitations of conventional radiographs.^{32,33} In all the articles included in this review, evaluation of the radiographs was performed by experienced and calibrated professionals.

From the eleven studies that used the PAI system²⁸ as criterium for diagnostic of AP, some studies used the $PAI \geq 2$ as a parameter for defining the presence of AP,^{1,17,19,21,23,25-27} and others used $PAI \geq 3$.^{9,16,22} As regards the studies that did not use the PAI as criterium for diagnostic of AP,^{18,20,24} Lupi-Pegurier et al¹⁸ and Estrela et al²⁴ used their own criteria, whereas Sunay et al²⁰ used criteria established by de Moor et al³⁸ (Table 1). Wu et al³⁴ as a limitation of the PAI, cited the fact of the wide variation in distance between the cortical bone and the root apex according to the dental group. Furthermore, some authors have questioned the use of subjective methods, based only on the observation of radiographic images.^{35,36} Camps et al³⁷ cited that the PAI allows only semi-qualitative results to be obtained, and does not allow comparison between groups. According to these authors, as a result of this, there will always be non-significant differences between groups, even with a large sample. To minimize the risk of false-negative results, these authors suggested the use of the gray value correction method, because the variations in the gray value of a

periapical lesion would be associated with the histological alterations.

Another point may raise some concern regarding the reliability of the PAI system. In the analysis of multi root teeth by PAI, some researchers included only the highest score,^{22,23,25,26} others preferred to use the lowest^{1,19} and some did not mention this information.^{9,16-18,20,21,24,27} This difference in the diagnostic parameters is another factor that makes it difficult to compare the data between the selected articles in this present review.

The ratio between quality of RF teeth and presence of AP showed results with great amplitude. When the frequency of AP in adequate RF teeth was evaluated in comparison with the total number of RF teeth, the range was from 0.1²⁶ to 41.6%.²³ In inadequate RF teeth with AP, this frequency ranged from 16.8²³ to 58.5%¹⁶ (Table 3). In the analysis of these data, apart from the small amount of information mentioned in the selected articles, considering that these studies were performed using samples including elderly persons (not exclusively), and the great variability of criteria used in the articles included in this review, it was concluding that inadequate root filling was associated with an increased prevalence of AP.

Normally, the teeth of elderly patients present a higher degree of difficulty with regard to performing endodontic treatments, either by the changes in their morphology, histology, and pulp physiology in comparison of the teeth in samples of younger age groups.^{24,30} These changes involve partial or complete occlusion of the pulp changes by the formation of tertiary dentin or pulp fibrosis, which reduces the vascular supply and consequently the response to aggressor agents.²⁶ Due to these particularities, it was hoped to find significant differences between the frequencies of adequate and inadequate RF in elderly patients. This fact emphasizes the importance of the development of an appropriate endodontic treatment in the prevention of AP occurrence.

The adequate endodontic treatment, the success of preventive dentistry, and the increase in longevity of the world population will lead to a growth of the expectation of maintenance of dentition in the elderly patients. This fact may result in an increase of the endodontic treatment needs in this population.² Thus, currently and in the future, more people will live longer and with more teeth in the oral cavity. Actions and public policies for the prevention of oral diseases should be directed to the elderly population, aiming at the equity and equality of opportunities in the maintenance of their oral health and teeth.

CONCLUSION

Based on the results of this systematic review, it was concluded that there are no studies that relate the quality of RF

and periapical status, represented by the absence/presence of AP, in samples formed exclusively of elderly persons. When studies that include elderly patients in the sample were used, inadequate root filling was associated with an increased prevalence of AP. There is a wide diversity of criteria for the analysis of the quality of RF teeth and the periapical status. Further, studies are needed to evaluate the effect of these facts on a possible increased demand for endodontic treatment in the elderly population.

REFERENCES

1. López-López J, Jané-Salas E, Estrugo-Devesa A, Castellanos-Cosano L, Martín-González J, Velasco-Ortega E, et al. Frequency and distribution of root-filled teeth and apical periodontitis in an adult population of Barcelona, Spain. *Int Dent J* 2012;62:40-46.
2. Müller F, Naharro M, Carlsson GE. What are the prevalence and incidence of tooth in the adult and elderly population in Europe? *Clin Oral Impl Res* 2007;18:2-14.
3. Kirkevang L-L. Root canal treatment and apical periodontitis: what can be learned from observational studies? *Endod Topics*. 2011;18:51-61.
4. Eckerbom M, Flygare L, Magnusson T. A 20-year follow-up study of endodontic variables and apical status in a Swedish population. *Int Endod J* 2007;40:940-948.
5. Jiménez-Pinzón A, Segura-Egea JJ, Poyato-Ferrera M, Velasco-Ortega E, Ríos-Santos JV. Prevalence of apical periodontitis and frequency of root-filled teeth in an adult Spanish population. *Int Endod J* 2004;37:167-173.
6. Genc Y, Gulsahi K, Gulsahi A, Yavuz Y, Cetinyurek A, Ungor M, et al. Assessment of possible risk indicators for apical periodontitis in root-filled teeth in an adult Turkish population. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;106: 72-77.
7. Hommez GM, Coppens CR, De Moor RJ. Periapical health related to the quality of coronal restorations and root fillings. *Int Endod J* 2002;35:680-689.
8. Hoskinson SE, Ng YL, Hoskinson AE, Moles DR, Gulabivala K. A retrospective comparison of outcome of root canal treatment using two different protocols. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;93:705-715.
9. Kirkevang LL, Hörsted-Bindslev P, Ørstavik D, Wenzel A. Frequency and distribution of endodontically treated teeth and apical periodontitis in an urban Danish population. *Int Endod J* 2001;34:198-205.
10. Frisk F, Hugoson A, Hakeberg M. Technical quality of root fillings and periapical status in root filled teeth in Jönköping, Sweden. *Int Endod J* 2008;41:958-968.
11. Eckerbom M, Andersson JE, Magnusson T. A longitudinal study of changes in frequency and technical standard of endodontic treatment in a Swedish population. *Endod Dent Traumatol* 1989; 5:27-31.
12. Petersson K. Endodontic status of mandibular premolars and molars in an adult Swedish population. A longitudinal study 1974-1985. *Endod Dent Traumatol* 1993;9:13-18.
13. Frisk F, Hakeberg M. A 24-year follow-up of root filled teeth and periapical health amongst middle aged and elderly women in Göteborg, Sweden. *Int Endod J* 2005;38:246-254.
14. Jackson N, Waters E. Guidelines for systematic reviews in health promotion and public health taskforce. Criteria for the systematic review of health promotion and public health interventions. *Health Promot Int* 2005;20(4):367-374.
15. Deeks JJ, Dinnes J, D'Amico R, Sowden AJ, Sakarovich C, Song F, et al. Evaluating non-randomised intervention studies. *Health Technology Assessment* 2003;7:1-173.
16. Kirkevang L-L, Ørstavik D, Hörsted-Bindslev P, Wenzel A. Periapical status and quality of root fillings and coronal restorations in a Danish population. *Int Endod J* 2000;33:509-515.
17. Boucher Y, Matossian L, Rilliard F, Machtou P. Radiographic evaluation of the prevalence and technical quality of root canal treatment in a French subpopulation. *Int Endod J* 2002;36: 229-238.
18. Lupi-Pegurier L, Bertrand M-F, Muller-Bolla M, Rocca JP, Bolla M. Periapical status, prevalence and quality of endodontic treatment in an adult French population. *Int Endod J* 2002;35: 690-697.
19. Jiménez-Pinzón A, Segura-Egea JJ, Poyato-Ferrera M, Velasco-Ortega E, Ríos-Santos JV. Prevalence of apical periodontitis and frequency of root-filled teeth in an adult Spanish population. *Int Endod J* 2004;37:167-173.
20. Sunay H, Tanalp J, Dikbas I, Bayirli G. Cross-sectional evaluation of the periapical status and quality of root canal treatment in a selected population of urban Turkish adults. *Int Endod J* 2007;40:139-145.
21. Özbas H, Asci S, Aydin Y. Examination of the prevalence of periapical lesions and technical quality of endodontic treatment in a Turkish subpopulation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2011;112:136-142.
22. Loftus JJ, Keating AP, McCartan B. Periapical status and quality of endodontic treatment in an adult Irish population. *Int Endod J* 2005;38:81-86.
23. Tsuneishi M, Yamamoto T, Yamanaka R, et al. Radiographic evaluation of periapical status and prevalence of endodontic treatment in an adult Japanese population. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005;100:631-635.
24. Estrela C, Leles CR, Hollanda ACB, Moura MS, Pécora JD. Prevalence and risk factors of apical periodontitis in endodontically treated teeth in a selected population of Brazilian adults. *Braz Dent J* 2008;19(1):34-39.
25. Touré B, Kane AW, Sarr M, Ngom CTH, Boucher Y. Prevalence and technical quality of root fillings in Dakar, Senegal. *Int Endod J* 2008;41:41-49.
26. Kamberi B, Hoxha V, Stavileci M, Dragusha E, Kuçi A, Kqiku L. Prevalence of apical periodontitis and endodontic treatment in a Kosovar adult population. *BMC Oral Health* 2010;11: 32-37.
27. Matijević J, Dadić TC, Mehičić GP, Anić I, Šljaj M, Krmek SJ. Prevalence of apical periodontitis and quality of root fillings in population of Zagreb, Croatia: a cross-sectional study. *Croat Med J* 2011;52:679-687.
28. Ørstavik D, Kerekes K, Eriksen HM. The periapical index: a scoring system for radiographic assessment of apical periodontitis. *Endod Dent Traumatol* 1986;2:20-34.
29. Pak JG, Fayazi S, White SN. Prevalence of periapical radiolucency and root canal treatment: a systematic review of cross-sectional studies. *J Endod* 2012;38(9):1170-1176.
30. Goodis HE, Rossall JC, Kahn AJ. Endodontic status in older US adults. Report of a survey. *J Am Dent Assoc* 2001;132(11): 1525-1530.
31. Estrela C, Bueno MR, Azevedo BC, Azevedo JR, Pécora JD. A new periapical index based on cone beam computed tomography. *J Endod* 2008;34:1325-1331.

32. Patel S, Wilson R, Dawood A, Mannocci F. The detection of periapical pathosis using periapical radiography and cone beam computed tomography—Part 1: preoperative status. *Int Endod J* 2011;45:702-710.
33. Patel S, Wilson R, Dawood A, Foschi F, Mannocci F. The detection of periapical pathosis using digital periapical radiography and cone beam computed tomography – Part 2: a 1-year post-treatment follow-up. *Int Endod J* 2012;45:711-723.
34. Wu M-K, Shemesh H, Wesselink PR. Limitations of previously published systematic reviews evaluating the outcome of endodontic treatment. *Int Endod J* 2009;42:656-666.
35. Goldman M, Pearson AH, Darzenta N. Reliability of radiographic interpretation. *Oral Surg Oral Med Oral Pathol* 1974;38:287-293.
36. Reit C, Hollender L. Radiographic evaluation of endodontic therapy and influence of observer variation. *Scan J Dent Res* 1983;91:205-212.
37. Camps J, Pommel L, Bukiet F. Evaluation of periapical lesion healing by correction of gray values. *J Endod* 2004;30(11):762-766.
38. De Moor RJ, Hommez GM, De Boever JG, Delmé KI, Martens GE. Periapical health related to the quality of root canal treatment in a Belgian population. *Int Endod J* 2000;33:113-120.