Hypertension and Dental Periapical Condition

Juan J. Segura-Egea, PhD, MD, DDS, *Elena Jimenez-Moreno, DDS, *Cristina Calvo-Monroy, DDS, *José V. Ríos-Santos, PhD, MD, DDS, †Eugenio Velasco-Ortega, PhD, MD, DDS, †Benito Sánchez-Domínguez, DDS, *Lizett Castellanos-Cosano, DDS, * and José María Llamas-Carreras, PhD, MD, DDS‡

Abstract

Introduction: The purpose of this study was to investigate the prevalence of apical periodontitis and endodontic treatment in hypertensive patients and control subjects without hypertension. Methods: In a cross-sectional study, the records of 40 hypertensive patients and 51 control subjects were examined. Periapical status of all teeth was assessed by using the periapical index score. Results: Apical periodontitis in 1 or more teeth was found in 75% of hypertensive patients and in 61% of control subjects (P = .15; odds ratio, 1.94; 95% confidence interval, 0.78–4.81). One or more root-filled teeth were found in 45% and 39% of hypertensive and control subjects, respectively (P > .05). Among hypertensive patients 5.2% of the teeth had apical periodontitis, whereas in the control subjects 4.2% of teeth were affected (P > .05). The percentages of root-filled teeth in the study and control groups were 3.1% and 1.8%, respectively (P > .05). Among hypertensive patients 65% of root-filled teeth had apical periodontitis, whereas in the control subjects 43% of the root-filled teeth were associated with apical periodontitis (P > .05). Conclusions: The prevalence of apical periodontitis and endodontic treatment was not significantly different in hypertensive patients compared with control subjects without hypertension. (J Endod 2010;36:1800–1804)

Key Words

Apical periodontitis, apical periodontitis epidemiology, coronary heart disease, endodontics, hypertension

Hypertension (HTN) or high blood pressure (BP) is a chronic medical condition in which the blood pressure in the arteries is elevated. It is classified as either primary or essential (90%–95% of cases), which refers to high BP for which no medical cause can be found, and secondary (5%–10% of cases), caused by other conditions that affect the kidneys, arteries, heart, or endocrine system (1). The diagnosis of HTN is made when the average of 2 or more diastolic BP measurements on at least 2 subsequent visits is ≥90 mm Hg or when the average of multiple systolic BP readings on 2 or more subsequent visits is consistently ≥140 mm Hg (2, 3). Persistent HTN is one of the risk factors for stroke, heart attack, heart failure, and arterial aneurysm and is a leading cause of chronic kidney failure. Moderate elevation of arterial blood pressure leads to shortened life expectancy (4).

During the last 10 years, several studies carried out in patients with periodontal disease have related HTN and chronic periodontal infections localized to the marginal periodontium (5). These studies demonstrate a relationship between high BP and more severe periodontal parameters in such a way that hypertensive patients show a poorer periodontal state (6–9).

Apical periodontitis is “an acute or chronic inflammatory lesion around the apex of a tooth caused by bacterial infection of the pulp canal system” (10). Histologically, it is represented by a periapical inflammatory response that arises after resorption of adjacent supporting bone and local infiltration of inflammatory cells. Despite numerous differences between chronic inflammatory disease of periodontal and endodontic origins, there are notable similarities (11), primarily that (1) both diseases are chronic infections affecting oral tissues, (2) both conditions share a common microbiota that often is associated with gram-negative anaerobic bacteria (12, 13), and (3) elevated systemic cytokines and inflammatory mediators levels have been observed in conjunction with both disease processes (14, 15). However, there are also important differences between endodontic and periodontal inflammation. Epidemiologic assessment of current and past periodontal inflammation can occur clinically through measurement of periodontal pockets, attachment loss, or both, but endodontic disease must be evaluated through observation of periapical bony lesions on radiographs (indicative of chronic endodontic inflammation) or of radiopaque material in the root canal system (indicative of history of endodontic therapy) (16).

Although the role of chronic apical periodontitis and endodontic therapy in the development of adverse systemic outcomes has not been thoroughly explored, several investigations suggest their association with type II diabetes (17–19) and coronary heart disease (11, 16, 20). Cigarette smoking, a risk factor for the development of HTN (21), has also been associated with periapical and endodontic status (22, 23).

The aim of the present study was to investigate the prevalence of apical periodontitis and endodontic treatment in hypertensive patients and control subjects without HTN.

Methods

Among the patients looking for routine dental care at the University of Seville, Faculty of Dentistry, 40 subjects reporting a history of well-controlled HTN diagnosed according to the criteria of the World Health Organization Guidelines Subcommittee (24) and receiving treatment for HTN were included in the study group. An additional 51 patients who were within the age range of the hypertensive patients who reported no
history of HTN and did not receive treatment for HTN served as control subjects. The total sample consisted of 91 subjects, 43 men (47%) and 48 women (53%), aged 56.8 ± 11.1 years. The scientific committee of the Dental Faculty approved the study, and all the patients gave informed written consent.

All participants underwent a full-mouth radiographic survey consisting of 14 periapical radiographs. All radiographs were taken with a Trophy CCX x-ray unit (Trophy Radiologie, Vincennes, France) by using the long-cone paralleling technique, setting of 70 kV, 10 mA, a film-focus distance of 28 cm, and Ultra Speed film (Eastman Kodak, Rochester, NY).

From the full-mouth radiographic survey all teeth, excluding third molars, were recorded. Teeth were categorized as root-filled teeth if they had been filled with radiopaque material in the root canal(s). The following information was recorded on a structured form for each subject: (1) number of teeth present, (2) number and location of teeth without root fillings (untreated teeth) having identifiable periapical lesions, (3) number and location of root-filled teeth, and (4) number and location of root-filled teeth having identifiable periapical lesions. The periapical status was assessed by using the periapical index (PAI) (25) as described previously (26, 27). One observer (an endodontist with 12 years of clinical experience) examined the radiographs. The method of viewing the radiographs was standardized. Films were examined in a darkened room by using an illuminated viewer box with magnification (3.5×) while mounted in a cardboard slit to block off ambient light emanating from the viewer. Before evaluation, the observer participated in a calibration course for PAI system, which consisted of 100 radiographic images of teeth, some root-filled and some not. Each tooth was assigned to 1 of the PAI scores by using visual references (25) for the 5 categories within the scale (Fig. 1, Table 1). After scoring the teeth, the results were compared to a gold standard atlas, and a Cohen kappa was calculated (0.71).

Intraobserver reproducibility was evaluated by the repeat scoring of 50 patients 2 months after the first examination. These patients were randomly selected. Before the second evaluation of the radiographs, the observer was recalibrated in the PAI system by scoring the 100 standard images. The intraobserver agreement test on PAI scores on the 50 patients produced a Cohen kappa of 0.77. A score greater than 2 (PAI ≥3) was considered to be a sign of periapical pathology. The worst score of all roots was taken to represent the PAI score for multirooted teeth.

Raw data were entered into Excel (Microsoft Corporation, Redmond, WA). All analyses were done in an SPSS environment (Version 11; SPSS, Inc, Chicago, IL). The χ² test and logistic regression analysis were used to determine the significance of differences between groups. Data are reported as mean (standard deviation).

**Results**

The study group consisted of 40 patients with HTN, 23 men and 17 women, ranging from 41–73 years old (59.5 (9.7 years). The control group consisted of 51 subjects without HTN, 20 men and 31 women, ranging from 40–74 years old (56.4 (9.9 years) (P > .05). The average number of teeth per patient was 21.2 (4.4 and 22.2 (4.3 teeth in hypertensive and control groups, respectively (P > .05).

Apical periodontitis in 1 or more teeth was found in 30 hypertensive patients (75%) and in 31 control subjects (61%) (P = .15; odds ratio, 1.94; 95% confidence interval [CI], 0.78–4.81) (Table 2). One or more root-filled teeth were found in 18 (45%) and 20 (39%) hypertensive and control subjects, respectively (P = .58). Among hypertensive patients with root-filled teeth, 13 (72%) had apical periodontitis affecting at least 1 treated tooth. In control subjects with root-filled teeth, 9 (45%) had apical periodontitis affecting at least 1 tooth.

**Table 1.** Periapical Index (25)

<table>
<thead>
<tr>
<th>Score</th>
<th>Criteria</th>
<th>Score</th>
<th>Criteria</th>
<th>Score</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal periapical structures</td>
<td>2</td>
<td>Small changes in bone structure</td>
<td>3</td>
<td>Changes in bone structure with some mineral loss</td>
</tr>
<tr>
<td>4</td>
<td>Periodontitis with well-defined radiolucent area</td>
<td>5</td>
<td>Severe periodontitis with exacerabating features</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.** Prevalence of Apical Periodontitis (AP), Root-filled Teeth (RFT), and Root-filled Teeth with Apical Periodontitis (RFT-AP) in Hypertensive (N = 40) and Control (N = 51) Subjects

<table>
<thead>
<tr>
<th></th>
<th>AP (%)</th>
<th>RFT (%)</th>
<th>RFT-AP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertensive</td>
<td>30 (75)</td>
<td>18 (45)</td>
<td>13 (72)</td>
</tr>
<tr>
<td>Control</td>
<td>31 (61)</td>
<td>20 (39)</td>
<td>9 (45)</td>
</tr>
<tr>
<td>Total</td>
<td>61 (67)</td>
<td>38 (42)</td>
<td>22 (58)</td>
</tr>
<tr>
<td>Odds ratio, hypertensive</td>
<td>1.9*</td>
<td>1.3*</td>
<td>3.2*</td>
</tr>
</tbody>
</table>

*p > .05.*
treated tooth \( (P = .09, \text{ odds ratio}, 3.18; 95\% \text{ CI}, 0.82–12.34) \). Neither univariate (Table 3) nor multivariate (Table 4) logistic regression analyses showed significant association between periapical status and hypertensive status.

The total number of teeth examined in the study group was 754; 39 (5.2%) had apical periodontitis (PAI >=3) (Table 5). Among the 1191 teeth examined in the control group, only 50 (4.2%) had apical periodontitis \( (P > .05) \). The number of root-filled teeth in the study and control groups was 23 (3.1%) and 21 (1.8%), respectively \( (P > .05) \). Among hypertensive patients, 15 root-filled teeth had apical periodontitis, whereas among the control patients, 9 root-filled teeth exhibited associated periapical radiolucency \( (P > .05) \). Finally, among untreated teeth, 24 and 41 were associated with apical periodontitis in hypertensive patients and control subjects, respectively \( (P > .05) \).

### Discussion

This cross-sectional study aimed to investigate the periapical status and the prevalence of endodontic treatment in hypertensive patients compared with control subjects without HTN. The results did not reveal a significant association between teeth with periapical status and HTN or between endodontically treated teeth and HTN.

The study included adult patients attending the dental service of the Faculty of Dentistry of Seville (Spain) for the first time. The recruitment of subjects was the same as those used by other investigators (17, 27, 28). There was no significant difference in age between both groups.

Periapical radiographs were used to evaluate the presence of apical periodontitis. Previous studies have also used periapical radiographs (22, 23, 26–29). Moreover, the PAI used for scoring periapical status was first described for periapical radiographs (25) and has been widely used in the literature (22, 27, 28, 30–32).

Numerous studies have related HTN and periodontal disease (6–9), but few studies have analyzed the possible association between HTN and endodontic variables, ie, apical periodontitis and root-filled teeth. It has been suggested that HTN might contribute to decreased retention of endodontically treated teeth (33); however, the results of the present study showed that the prevalence of endodontic treatment is not significantly different in hypertensive patients compared with control subjects. A recent prospective epidemiologic study that used self-reported history of endodontic therapy concluded that HTN was more prevalent among patients with coronary heart disease (CHD), with 24 or fewer teeth reported as never having had endodontic treatment (34). An earlier cross-sectional study, designed to explore a possible association between endodontic disease variables and CHD, did not find significant association between periapical disease or endodontically treated teeth and CHD (35).

Several animal models have been developed to study the relationship between HTN and oral infections, but they focused on periodontal disease. The first report relating high BP with oral infections in animals found hyperplasia/hypertrophy in the blood vessel walls from chronically irritated gingiva in hypertensive and obese-hypertensive rats (36). However, HTN alone was not a significant factor. In contrast to this, another report (37) in which an experimental ligature-induced periodontitis model was used in spontaneously hypertensive and normotensive rats found that the ligated sides in the experimental group showed moderate to severe collagen degradation in the alveolar process, compared with mild degradation in controls.

The results of the studies carried out in humans support the existence of a relationship between high BP and more severe periodontal parameters in such a way that individuals with HTN show a poorer periodontal status (5–9). Moreover, periodontal disease can negatively influence certain features of HTN, such as an increase in the left ventricular mass (38). However, none of these studies controlled for the periapical status of the patients. Therefore, taking into account the high prevalence of apical periodontitis (26, 27), endodontic disease could be acting as a confounding variable. Recently, 2 studies investigated whether there is a correlation between infections of dental origin and the occurrence of myocardial infarction, taking into consideration both periodontal and periapical lesions (39, 40). Results demonstrated that patients with acute myocardial infarction exhibited a significantly higher number of missing teeth, less teeth with root canal fillings, a higher number of radiologic apical lesions, and a higher periodontal screening index value compared with individuals without myocardial infarction. Bearing in mind that HTN is a risk factor for stroke (4), these results further support the concept that endodontic variables could be associated with HTN.

Periapical disease and periodontal disease are both chronic infections affecting oral tissues and share a common gram-negative anaerobic microbiota (12, 13). Furthermore, increased concentrations of cytokines and inflammatory mediators have been detected both in

### Table 3. Univariate Logistic Regression Analysis of Influence of Independent Variables of Age, Gender, Number of Teeth, Apical Periodontitis (AP), Root-filled Teeth (RFT), Root-filled Teeth with Apical Periodontitis (RFT-AP), and Untreated Teeth with Apical Periodontitis (UT-AP) on the Dependent Variable, Hypertensive Status

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>B</th>
<th>P value</th>
<th>Odds ratio</th>
<th>95% CI inferior limit</th>
<th>95% CI superior limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.0325</td>
<td>.1415</td>
<td>1.0330</td>
<td>0.9892</td>
<td>1.0787</td>
</tr>
<tr>
<td>Gender</td>
<td>0.7405</td>
<td>.0848</td>
<td>2.0971</td>
<td>0.9035</td>
<td>4.8674</td>
</tr>
<tr>
<td>No. of teeth</td>
<td>-0.0549</td>
<td>.2635</td>
<td>0.9466</td>
<td>0.8598</td>
<td>1.0422</td>
</tr>
<tr>
<td>AP</td>
<td>0.6604</td>
<td>.1550</td>
<td>1.9355</td>
<td>0.7790</td>
<td>4.8087</td>
</tr>
<tr>
<td>RFT</td>
<td>0.2376</td>
<td>.5789</td>
<td>1.2682</td>
<td>0.5480</td>
<td>2.9349</td>
</tr>
<tr>
<td>RFT-AP</td>
<td>0.8096</td>
<td>.1046</td>
<td>2.2469</td>
<td>0.8451</td>
<td>5.9737</td>
</tr>
<tr>
<td>UT-AP</td>
<td>-0.0177</td>
<td>.9666</td>
<td>0.9825</td>
<td>0.4288</td>
<td>2.2511</td>
</tr>
</tbody>
</table>

### Table 4. Multivariate Logistic Regression Analysis of Influence of Independent Variables of Age, Gender, Number of Teeth, Apical Periodontitis (AP), and Root-filled Teeth (RFT) on the Dependent Variable, Hypertensive Status

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>B</th>
<th>P value</th>
<th>Odds ratio</th>
<th>95% CI inferior limit</th>
<th>95% CI superior limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.0251</td>
<td>.2731</td>
<td>1.0254</td>
<td>0.9804</td>
<td>1.0724</td>
</tr>
<tr>
<td>No. of teeth</td>
<td>-0.0486</td>
<td>.3749</td>
<td>0.9525</td>
<td>0.8556</td>
<td>1.0605</td>
</tr>
<tr>
<td>AP</td>
<td>0.5683</td>
<td>.2394</td>
<td>1.7653</td>
<td>0.6850</td>
<td>4.5494</td>
</tr>
<tr>
<td>RFT</td>
<td>-0.0529</td>
<td>.9126</td>
<td>0.9485</td>
<td>0.3688</td>
<td>2.4393</td>
</tr>
</tbody>
</table>
gingival crevicular fluid of subjects with periodontal disease and in periapical tissues of endodontically involved teeth (14, 15). Diabetes (16–18), smoking (22, 23), and CHD (11, 19, 20) have been associated with both periodontal and apical diseases (5). These similarities between both oral infectious diseases support the concept that periapical disease and endodontic treatment could be associated with HTN. One mechanism explaining the relationship between high BP and periapical status is inflammatory response. Published data suggest that chronic inflammation could be an independent risk factor for HTN. A significant association between inflammatory markers and elevated BP in apparently healthy patients has been reported (41). C-reactive protein (CRP) has been shown to be associated with HTN in a few well-controlled studies (42, 43). In addition, CRP level is associated with future development of HTN, which means that HTN is, in part, an inflammatory disorder (44). Similarly, some studies in human subjects have shown a positive association between interleukin (IL)-6 and tumor necrosis factor (TNF)-α levels, 2 markers of chronic mild inflammation, and the presence of HTN among apparently healthy subjects (45) and hypertensive patients (41, 46). In agreement with this hypothetical mechanism of association between apical periodontits and HTN, the production of proinflammatory cytokines such as IL-6 and TNF-α in periapical lesions has been shown (14, 47, 48). Moreover, significantly higher concentrations of IL-6, CRP, and TNF-α within the liver of rats with induced periapical abscesses have been shown (49).

The results of the present study conclude that prevalence of apical periodontitis and endodontic treatment is not significantly different in hypertensive patients compared with control subjects without HTN. However, this study has several limitations. First, there are factors not recorded, such as prevalence of diabetes and smoking habits, that could affect the incidence of both apical periodontitis and HTN, acting as confounding factors. Second, the quality of root canal filling and coronal restoration, which has not been considered when evaluating the presence of apical periodontitis, has been shown to be major predictors of endodontic success and also could act as confounding factors. A large prospective clinical and interventional study, controlling all the possible confounding factors, will be needed to definitively assess the relationship between HTN and endodontic variables.

**Acknowledgments**

*The authors deny any conflicts of interest.*

**References**


**TABLE 5. Distribution of Teeth with Apical Periodontitis (AP), Root-filled Teeth (RFT), Root-filled Teeth with Apical Periodontitis (RFT-AP), and Untreated Teeth with Apical Periodontitis (UT-AP) in Hypertensive and Control Subjects**

<table>
<thead>
<tr>
<th></th>
<th>Total teeth</th>
<th>AP</th>
<th>RFT</th>
<th>RFT-AP</th>
<th>UT-AP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypertensive</strong></td>
<td>754</td>
<td>39 (5.2)</td>
<td>23 (3.1)</td>
<td>15 (65.2)</td>
<td>24 (3.3)</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>1191</td>
<td>50 (4.2)</td>
<td>21 (1.8)</td>
<td>9 (42.9)</td>
<td>41 (2.5)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1945</td>
<td>89 (4.6)</td>
<td>44 (2.3)</td>
<td>24 (54.5)</td>
<td>65 (3.4)</td>
</tr>
<tr>
<td><strong>OR, hypertensive</strong></td>
<td>1.2*</td>
<td>1.8*</td>
<td>2.5*</td>
<td>4.5*</td>
<td></td>
</tr>
</tbody>
</table>

OR, odds ratio.

*P < .05.


