Periapical status and quality of root fillings and coronal restorations in an adult Spanish population

J. J. Segura-Egea, A. Jiménez-Pinzón, M. Poyato-Ferrera, E. Velasco-Ortega & J. V. Ríos-Santos
Department of Stomatology, School of Dentistry, University of Seville, Seville, Spain

Abstract

Aim To investigate the quality of root fillings and coronal restorations and their association with periapical status in an adult Spanish population.

Methodology A total of 180 subjects, aged 37.1 ± 15.7 years, who presented as new patients at the Faculty of Dentistry, Seville, Spain, were examined. All participants underwent a full-mouth radiographic survey incorporating 14 periapical radiographs. The periapical region of all root filled teeth, excluding third molars, were examined. The technical quality of root fillings was evaluated in terms of length in relation to the root apex and lateral adaptation to the canal wall. Radiographic signs of overhang or open margins associated with coronal restorations were also evaluated. Periapical status was assessed using the Periapical Index score. Statistical analyses were conducted using the Cohen’s $\kappa$ test and logistic regression.

Results The total number of root filled teeth was 93, and 60 (64.5%) had apical periodontitis (AP). Presence of AP in root filled teeth was associated with inadequate adaptation of the filling (OR = 2.29; $P = 0.06$), inadequate length of the root filling (OR = 2.44; $P = 0.048$), and with poor radiographic quality of the coronal restoration (OR = 2.38; $P = 0.054$). Only 34.4% of the root fillings were adequate from a technical perspective. When both root fillings and coronal restorations were adequate the incidence of AP decreased to 31.3% (OR = 5.50; $P < 0.01$).

Conclusions The incidence of AP in root filled teeth was high. Many root fillings were technically unsatisfactory. Adequate root fillings and coronal restorations were associated with a lower incidence of AP; an adequate root filling had a more substantial impact on the outcome of treatment than the quality of the coronal restoration.

Keywords: apical periodontitis, coronal restoration, endodontics, periapical status, root fillings.

Introduction
Follow-up clinical studies have shown that root canal treatment applying modern principles of practice can yield favourable outcomes, with healing rates well above 90% (Sjögren et al. 1990, Ørstavik 1996, Friedman 1998). However, most of the investigations on the quality and prognosis of root canal treatment have been based on clinical studies made in controlled environments at dental schools or in specialist clinics (Strindberg 1956, Ørstavik & Hörsted-Binslev 1993, Çalışkan & Sen 1996, Iqbal et al. 2003). The high rates of success reported in these studies were obtained with well-trained practitioners under strict operating conditions that may not reflect the situation found within the average dental clinic (Boucher et al. 2002). Such studies demonstrate the potential outcome of root canal treatment rather than its realistic outcome in general practice (Eriksen et al. 2002).
Recent endodontic epidemiological studies carried out in different population groups report a high prevalence of apical periodontitis (AP) in connection with root filled teeth ranging from 16 to 65% (Weiger et al. 1997, Eriksen 1998, Kirkevang et al. 2001, Dugas et al. 2003, Jiménez-Pinzón et al. 2004), as well as a frequent finding of root fillings of inadequate quality (Ödesjö et al. 1990, Marques et al. 1998, Sidaravicius et al. 1999, Kirkevang et al. 2000, Lupi-Pegurier et al. 2002). These epidemiological studies point to an association between the quality of root canal treatment and periapical bone status, and conclude that an improvement in the quality of root canal treatment in general dental practice was required in order to promote periapical health (Kirkevang et al. 2000). In addition, it has been suggested that the quality of the coronal restoration may be of greater importance for the periapical status than the quality of the endodontic treatment (Ray & Trope 1995, Sidaravicius et al. 1999, Iqbal et al. 2003).

The aim of the present study was to relate the quality of root canal treatment and coronal restorations to the periapical status of root filled teeth in an adult Spanish population based on radiographic examination.

Materials and methods

Patient selection

The sample consisted of 180 subjects, aged 37.1 ± 15.7 years, 66 males (36.7%) and 114 females (63.3%), presenting consecutively as new patients seeking routine dental care (not emergency care) at the University of Seville, Faculty of Dentistry, in the years 2002 and 2003. The criteria for inclusion in the study were that the patients should be attending for the first time. Patients younger than 18 years and patients having less than eight remaining teeth were excluded. The scientific committee of the Dental Faculty approved the study and all the patients gave written informed consent.

Radiographic examination

All participants underwent a full-mouth radiographic survey consisting of 14 periapical radiographs. All radiographs were taken with a Throphy CCX X-ray unit (Trophy Radiologie – 94300, Vincennes, France) and processed manually by two experienced dental assistants. Two experienced radiographers 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, USA), took all periapical radiographs.

Radiographic evaluation

From the full-mouth radiographic survey all root filled teeth, excluding third molars, were recorded according to the FDI nomenclature. Teeth were categorized as root filled teeth if they had been filled with a radiopaque material in the pulp chamber and/or in the root canal(s). In the root filled teeth the parameters listed in Table 1 were assessed. The periapical status was assessed using the ‘Periapical Index’ (PAI) score (Ørstavik et al. 1986), recorded for each one of the roots. The worst score of all roots was taken to represent PAI score for multirooted teeth. A score greater than 2 (PAI > 2) was considered to be a sign of periapical pathology (Ørstavik et al. 1986).

Observer

One observer with 6 years of clinical experience in endodontics examined the radiographs. The method of viewing the radiographs was standardized: films were examined in a darkened room using an illuminated viewer box with magnification (3.5×) whilst mounted in a cardboard slit to block off ambient light emanating from the viewer. Before evaluation, the observer participated in a calibration course for the PAI system, which consisted of 100 radiographic images of teeth (kindly provided by Dr Ørstavik), some root filled and some not. Each tooth was assigned to one of the five PAI scores using visual references (also provided by Dr Ørstavik) for the five categories within the scale. After scoring the teeth, the results were compared with a ‘gold standard atlas’, and Cohen’s $\kappa$ was 0.71.

Intra-observer reproducibility was evaluated by the repeat scoring of 50 individuals’ radiographs 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’s $\kappa$ of 0.77.

Statistical analysis

Diagnostic thresholds for the present study were (Table 1):
Adaptation of root filling to canal walls: adequate if no voids were present in the root filling; score 1 = adequate, and scores 2, 3 and 4 = inadequate.

Length of root filling: adequate if ending £3 mm from, or flush with, the radiographic apex; score 1 and 4 = adequate, and scores 2, 3 and 5 = inadequate.

Periapical bone: score 1 and 2 = sound, and scores 3, 4 and 5 = diseased (AP).

Raw data were entered in Excel® (Microsoft Corporation, Redmond, WA, USA). All analyses were done in an SPSS environment (Version 11; SPSS, Inc., Chicago, IL, USA). Logistic regression was used for statistical evaluation of the results. Odds ratio with 95% confidence interval (CI) was calculated.

### Results

The total number of root filled teeth was 93; AP was present in 60 teeth (64.5%). Table 2 shows the relationship between the adaptation of root filling to canal walls and periapical status. Root filled teeth without voids had AP in 55.3% of cases, whereas if voids were detected, disease was present in 73.9% of the teeth (P = 0.063; odds ratio = 2.29; CI = 0.96–5.50).

The relationship between the length of the root filling and periapical status is shown in Table 3. Apical periodontitis was found in 55.1% of teeth with adequate length of root filling, whereas if the filling was too short or long, periapical lesions were present in 75% of teeth (P = 0.048; odds ratio = 2.44; CI = 1.01–5.92).

The relationship between the quality of the coronal restoration and periapical status is presented in Table 4. Approximately 50% of the teeth with adequate coronal restorations had AP, whereas if the coronal restoration was inadequate, disease was present in 71.7% of the teeth (P = 0.054; odds ratio = 2.38; CI = 0.98–5.76).

Teeth that had root fillings with adequate length, as well as adequate adaptation of the filling to the canal...
walls were tested against any other combination of treatment quality (adequate length/inadequate adaptation, inadequate length/adequate adaptation, and inadequate length/inadequate adaptation) (Table 5). Both length and adaptation was found to be adequate in 32 teeth (34.4%), and 46.9% of these teeth had periapical lesions, significantly less than any other combination ($P = 0.011$; odds ratio $= 3.19$; CI $= 1.30–7.83$). The 29 teeth with both inadequate length and adaptation of root fillings were compared with the other combinations of treatment quality; 75.9% of these teeth had periapical lesions whereas periapical disease was present in 59.4% of the other teeth ($P = 0.128$).

Finally, all three-quality parameters were combined. Coronal restoration, filling adaptation, and length were found to be adequate only in 16 teeth (17.2%), and less than one-third of these teeth had AP ($P = 0.004$; odds ratio $= 5.50$; CI $= 1.71–17.67$). In 20 teeth both the coronal and the root filling were inadequate, and when they were tested against any other combination of the quality parameters, this was significantly better than any other combination ($P = 0.27$).

The multivariate logistic regression analysis combining two independent variables: (i) quality of root filling (both adaptation and length), and (ii) quality of coronal restoration, for the variable ‘periapical status’ (Table 6), demonstrated that quality of root filling ($P = 0.028$; odds ratio $= 2.81$; CI $= 1.12–7.06$) affected significantly the periapical status, but quality of the coronal restoration had no effect ($P = 0.15$; odds ratio $= 1.97$; CI $= 0.78–4.95$).

### Discussion

The study population has been described previously, as well as the possible causes contributing to the high proportion (65%) of apical lesions in connection with root filled teeth at the disease threshold utilized (Jiménez-Pinzón et al. 2004). Previous epidemiological surveys have also shown a high prevalence of AP in connection with root filled teeth, ranging between 22 and 61% (Saunders et al. 1997, Weiger et al. 1997, Marques et al. 1998, Sidaravicius et al. 1999, Kirkevang et al. 2001, Dugas et al. 2003).

In the present study the quality of the adaptation to the root canal walls, the length of the root filling, and the quality of the coronal restoration were evaluated in relation to periapical status. The limitations of the method used included the following: radiographic

### Table 4

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total no. of teeth</th>
<th>Healthy (%)</th>
<th>Diseased (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate coronal restoration</td>
<td>33</td>
<td>16 (48.5)</td>
<td>17 (51.5)</td>
</tr>
<tr>
<td>Inadequate coronal restoration</td>
<td>60</td>
<td>17 (28.3)</td>
<td>43 (71.7)</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
<td>33 (35.5)</td>
<td>60 (64.5)</td>
</tr>
</tbody>
</table>

Logistic regression: $P = 0.054$.

### Table 5

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total no. of teeth</th>
<th>Healthy (%)</th>
<th>Diseased (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate adaptation + length</td>
<td>32</td>
<td>17 (53.1)</td>
<td>15 (46.9)</td>
</tr>
<tr>
<td>Any other quality combination</td>
<td>61</td>
<td>16 (26.2)</td>
<td>45 (73.8)</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
<td>33 (35.5)</td>
<td>60 (64.5)</td>
</tr>
<tr>
<td>Inadequate adaptation + length</td>
<td>29</td>
<td>7 (24.1)</td>
<td>22 (75.9)</td>
</tr>
<tr>
<td>Any other quality combination</td>
<td>64</td>
<td>26 (40.6)</td>
<td>38 (59.4)</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
<td>33 (35.5)</td>
<td>60 (64.5)</td>
</tr>
</tbody>
</table>

Logistic regression: $P = 0.011$.

Logistic regression: $P > 0.05$.

Logistic regression: $P = 0.004$.

### Table 6

<table>
<thead>
<tr>
<th>Treatment</th>
<th>$B$</th>
<th>ET</th>
<th>Wald</th>
<th>gl</th>
<th>$P$</th>
<th>Exp($B$)</th>
<th>95% CI inf. limit</th>
<th>95% CI sup. limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>QCR</td>
<td>0.679</td>
<td>0.470</td>
<td>2.090</td>
<td>1</td>
<td>0.148</td>
<td>1.973</td>
<td>0.785</td>
<td>4.954</td>
</tr>
<tr>
<td>QEF</td>
<td>1.034</td>
<td>0.470</td>
<td>4.846</td>
<td>1</td>
<td>0.028</td>
<td>2.811</td>
<td>1.120</td>
<td>7.058</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.245</td>
<td>0.335</td>
<td>13.841</td>
<td>1</td>
<td>0.000</td>
<td>0.288</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exp($B$) = odds ratio.
assessment only, and small sample size of root filled teeth, i.e. only 93 in the 180 patients studied. Thus, the results of this study and its conclusions should be drawn with caution.

A number of reports on the effects of root canal treatment on periapical status have been published. The population included in these studies were not homogeneous, and the methods evaluating the quality of root filling and periapical status also differed, nevertheless, all used radiographs. However, it is impossible to assess the quality of root canal debridement procedures from radiographs. The radiographic appearance of a filled canal is only a gross sign of its sealing capacity (Weiger et al. 1997).

In the present study approximately 49% of the root fillings were not adapted to the canal wall, and of these, 73.9% had AP. Similar results have been reported in previous studies: percentages between 30 and 60% of root fillings were not adapted to the canal wall, and of these, 71.7% of the teeth with inadequate coronal restoration had AP. Other investigators (Kirkevang et al. 2000, Dugas et al. 2003) found a significant correlation between the radiographic quality of the coronal restoration and the periapical status of root filled teeth; but not as pronounced as Ray & Trope (1995).

When the quality of the root fillings and the quality of coronal restoration were combined, an even more pronounced pattern was seen. When both were of high quality, 68.9% of the teeth had healthy periapical bone ($P = 0.004$). Kirkevang et al. (2000) and Dugas et al. (2003) found similar percentages: 70 and 81%, respectively. This strongly indicates that both factors play important roles in obtaining an efficient seal of root canal. However, the results of the present study suggest that an adequate root filling had a more decisive impact on the outcome of treatment. Multivariate logistic regression analysis provide a significant odds ratio of 2.81 ($P = 0.028$) for adequate root filling, and a non-significant odds ratio of 1.97 ($P = 0.148$) for adequate coronal restoration, corroborating the results reported by other authors (Sidaravicius et al. 1999, Kirkevang et al. 2000, Tronstad et al. 2000, Dugas et al. 2003).

**Conclusions**

Apical periodontitis was present in 64.5% of root filled teeth. Within the limitations of this study, the results indicate that an adequate root filling had a more substantial impact on the outcome of treatment than the quality of coronal restorations. Both inadequate root filling and coronal restorations were associated with an increased incidence of AP. On the contrary, adequate root fillings and coronal restorations significantly reduced the incidence of AP. Many root canal treatments were technically unsatisfactory and substantial efforts must be made to improve the standard of endodontic treatment in Spain.

**References**


