



Restoring teeth that are endodontically treated through existing crowns. Part II: Survey of restorative materials commonly used

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Objective: A survey was undertaken to categorize the materials used for the restoration of endodontic access openings through complete-coverage crowns after completion of nonsurgical root canal treatment.

Method and materials: The survey package consisted of a cover letter stating instructions, rationale, and purpose for the questionnaire, a questionnaire of 8 short-answer questions, and a stamped, self-addressed envelope. A randomized sample of active dentists (300 general practitioners, 300 prosthodontists, and 300 endodontists), was selected. Collected data were analyzed with the chi-square analysis.

Results: Most general practitioners (93%), endodontists (61%), and prosthodontists (75%) reported that they frequently or always permanently restore teeth after nonsurgical root canal treatment. Empress was the all-ceramic system used most commonly by prosthodontists (42%) and general practitioners (38%). A statistically significant difference in restorative material preference was found ($P < 0.0001$), depending on the type of crown used. **Conclusion:** Amalgam alone and in combination with bonding agents are materials of choice for restoration of access openings through all-metal complete crowns, while resin composite is the choice for all types of complete crowns involving porcelain. Endodontists preferred "other" materials. (*Quintessence Int* 2000;31:719-728)

Key words: amalgam, bonding agent, complete-coverage crown, glass-ionomer cement, nonsurgical root canal treatment, resin composite, survey

CLINICAL RELEVANCE: Information gathered from this survey will institute guidelines for an in vitro study to identify which currently used materials minimize leakage in restored endodontic access openings through complete-coverage crowns.

The need for evidence-based treatment is surfacing throughout the medical and dental community as a consequence of society's demand for responsible and predictable health care. The escalating avalanche of new knowledge and increasing public expectation and demand for successful outcomes from the services rendered by health science professionals have been identified as 2 major factors pushing the need for evidence-based treatment.¹ However, over the past 25 years, the explosion of new techniques, materials, and treatment philosophies in dentistry has created a trend to rely on anecdotal information and disregard the importance of clinical research. The anecdotal approach, however seductive and appealing, cannot stand up to an evidence-based foundation when the responsibility of caring for people is involved.² It is necessary therefore, to adapt evidence-based support for the selection of treatment choices that combine both the clinical and research directives that result in the delivery of quality and predictable oral health care.

Advances in current technology provide the practitioner with a variety of choices in materials for restoring endodontically treated teeth. At times, these materials are introduced to the practitioner through an aggressive

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marketing strategy and may lack proper scientific testing to guarantee longevity and performance. Therefore, clinicians are exposed to a wide range of materials for which success is determined by trial and error.

One aspect of the materials' properties is the ability to obtain proper coronal seal, thereby protecting the pulp and internal anatomy of the tooth from bacterial exposure. However, to seal against all oral fluids is impossible, and, to date, none of the presently available restorative materials provides a complete seal.^{3,4} The integrity of these materials must therefore be investigated to provide a scientific basis for their clinical use.

Endodontists estimate that 20% to 50% of root canal treatment is performed through complete-coverage crowns.⁵ Once the coronal aspect of the root canal system is exposed to the oral environment through leaking crown margins or recurrent caries, the ingress of bacteria to the periapical tissues may be unavoidable. Likewise, coronal leakage has been identified as a major factor in the bacterial contamination of previously treated root canals and the subsequent failure of this treatment.⁵⁻¹¹ Given that coronal leakage is a significant cause of the failure of nonsurgical root canal treatment (NSRCT), the long-term success of root canal therapy that is performed through existing artificial crowns is highly dependent on the seal of the access opening made through the crown.

For teeth with complete-coverage crowns, marginal leakage and intermaterial leakage must be considered when the materials used to seal the NSRCT access opening from the ingress of oral microorganisms are evaluated. The restorative material placed in the access cavity of these teeth should allow minimal or no leakage. The choice of restorative material placed in the access opening of crowned teeth that receive NSRCT is based routinely on empiricism and personal preference.¹² Presently, there are no studies that provide evidence-based research as to the best material for the restoration of the access opening through artificial crowns.

The purpose of this study was to categorize, through the data obtained in a survey, the materials used by practitioners for the restoration of endodontic access openings through complete-coverage crowns. The data in the first part of the survey identified issues concerning the long-term success of complete-coverage restorations, their need for nonsurgical root canal treatment, and its association with leakage when encountered in contemporary clinical practice.¹³

METHOD AND MATERIALS

The design of the questionnaire for this study was detailed in part I of this series.¹³ Survey items were created to address a number of unresolved clinical

issues. Issues included the practitioner's understanding of coronal leakage and the preference of contemporary restorative materials to be used with various types of complete-coverage crowns. The questions focused on the clinical scenario of endodontically accessed teeth with preexisting complete-coverage crowns.

In part I of this survey, different case situations encountered in practice were addressed, including the longevity and failure of crowns, the pulpal condition, and the practitioners' views on the relevance of leakage to the ultimate success of the crown. In part II of the survey, the respondents' attitudes toward permanent restoration of endodontically treated teeth and specific restorative techniques for sealing the access cavity of teeth treated through complete-coverage crowns are addressed.

The attitudes and practices of general practitioners, prosthodontists, and endodontists as ascertained from this survey were compared with chi-squared tests of independence. All statistical analyses were performed with SPSS statistical software (version 9.0, SPSS).

RESULTS

Nine hundred surveys were initially mailed within a time span of 90 days. Of the 900 surveys sent out, 543 were completed and returned, representing a 60% response. As described previously, the survey was designed to address 2 distinct issues. The results of questions that addressed the issues of the longevity and failure of crowns, the pulpal condition on entry through a complete-coverage crown, the respondents' attitude toward restoration of recently endodontically treated teeth, and their views on the relevance of leakage to the success or failure of the endodontic therapy are described in part I of this series.¹³

This section of the survey targeted the issue of restoring the endodontically treated, complete-coverage fixed crown on completion of endodontic therapy and provisional restoration of the tooth during the course of the endodontic procedure. Practitioners were asked whether they restored access openings through complete-coverage crowns, the type of all-ceramic system used (if any), and what types of materials they used to restore access openings through various types of complete-coverage crowns. The applicable questions from the survey are shown in Fig 1.

The overall response to the first question was 99% (535/543). Table 1 details the responses of each practitioner group along with the respective response rates for restoring access openings of endodontically treated, crowned teeth. All practitioner groups had similarly high response rates; at least 98% of each practitioner group responded to the question.

Fig 1 Questionnaire items.

I restore access openings through crowns:

- ☐ Always.
☐ Frequently.
☐ Seldom.
☐ Never.

If you use an all-ceramic system, which one is used most commonly?

- ☐ Procera _____ %
☐ Empress _____ %
☐ OPC _____ %
☐ Inceram (specify): _____ %
☐ Other (specify): _____ %

I restore an access opening through a... (please choose more than one answer, if applicable; % should add up to 100%):

| Crown | Restoration | | | | | Total |
|---|---------------|---------------------|-----------------|---------------|---------|-------|
| | Amalgam alone | Amalgam and bonding | Resin composite | Glass ionomer | Other | |
| Complete metal crown with high-noble alloy (gold) | _____ % | _____ % | _____ % | _____ % | _____ % | 100% |
| Complete metal crown with noble alloy (other metals) | _____ % | _____ % | _____ % | _____ % | _____ % | 100% |
| Complete ceramic-fused-to-metal crown with high-noble alloy (gold) | _____ % | _____ % | _____ % | _____ % | _____ % | 100% |
| Complete ceramic-fused-to-metal crown with noble alloy (other metals) | _____ % | _____ % | _____ % | _____ % | _____ % | 100% |
| All-ceramic crown | _____ % | _____ % | _____ % | _____ % | _____ % | 100% |

TABLE 1 Frequency of restoration of access openings through crowns

| Practitioner type | Response rate | Restore access openings | | | |
|-------------------|---------------|-------------------------|---------------|--------------|--------------|
| | | Always | Frequently | Seldom | Never |
| Endodontists | 98% | 36% (72/198) | 25% (49/198) | 24% (47/198) | 15% (30/198) |
| Prosthodontists | 98% | 54% (93/172) | 21% (36/172) | 19% (32/172) | 6% (11/172) |
| General dentists | 99% | 67% (111/165) | 26% (43/165) | 5% (8/165) | 2% (3/165) |
| All practitioners | 96% | 52% (276/535) | 24% (128/535) | 16% (87/535) | 8% (44/535) |

A chi-squared test of independence was conducted to test for differences in the frequency of restoring access openings among practitioner groups. Statistically significant differences in the frequency of restoring access openings of endodontically treated crowned teeth were found ($P < 0.0001$) among the 3 practitioner types (endodontists, prosthodontists, and general practitioners). Specifically, general practitioners were more likely to respond that they "always" restore access openings than were prosthodontists and endodontists.

General practitioners responded "always" 67% of the time, prosthodontists responded "always" 54% of the time, and endodontists responded "always" 36% of the time. In addition, endodontists were most likely to respond that they "seldom" or "never" restore access openings (39%), while general practitioners were least likely to respond that they "seldom" or "never" restore access openings through crowns (7%). Prosthodontists' response of "seldom" or "never" restoring access openings through crowns fell between these 2 groups (25%).

TABLE 2 Most commonly used all-ceramic systems*

| Practitioner type | Response rate | Most commonly used all-ceramic system | | | | |
|-------------------|---------------|---------------------------------------|----------------|---------------|----------------|------------|
| | | Procera | In-Ceram | Empress | OPC | Other |
| Endodontists | 2% | 25% (1/4) | 0% (0/4) | 25% (1/4) | 0% (0/4) | 50% (2/4) |
| Prosthodontists | 90% | 20% (32/157) | 29% (45.5/157) | 41% (65/157) | 8% (12.5/157) | 1% (2/157) |
| General dentists | 71% | 14% (16.5/117) | 22% (25.5/117) | 41% (48/117) | 19% (22/117) | 4% (5/117) |
| All practitioners | 51% | 18% (49.5/278) | 26% (71/278) | 41% (114/278) | 12% (34.5/278) | 3% (9/278) |

*Total preferences, adjusted for ties. When a practitioner gave 2 systems equal weight, half was allotted to each system in tallying preferences by practitioner type.

TABLE 3 Most commonly used all-ceramic systems (ties and "other" category eliminated)

| Practitioner type | Most commonly used all-ceramic system | | | |
|-------------------|---------------------------------------|--------------|--------------|--------------|
| | Procera | In-Ceram | Empress | OPC |
| Prosthodontists | 23% (26/114) | 28% (32/114) | 44% (50/114) | 5% (6/114) |
| General dentists | 13% (12/89) | 22% (20/89) | 43% (38/89) | 21% (19/89) |
| Both groups | 19% (38/203) | 26% (52/203) | 43% (88/203) | 12% (25/203) |

TABLE 4 Frequency of use of all-ceramic systems

| Practitioner type | Response rate | Frequency of use | | | | |
|-------------------|---------------|------------------|----------|---------|-------|-------|
| | | Procera | In-Ceram | Empress | OPC | Other |
| Prosthodontists | 90% | 19.4% | 28.6% | 41.6% | 6.9% | 1.9% |
| General dentists | 71% | 15.4% | 20.4% | 38.4% | 19.7% | 5.7% |
| Both groups | 81% | 17.7% | 25.1% | 40.3% | 12.4% | 3.5% |

Tables 2 and 3 detail the total responses to the second question (all-ceramic system used) by practitioner type. Table 2 shows the responses for all groups with adjustments made for practitioners who reported equal use of 2 systems (adjustment was made for "ties"). Because of the small number of responses by endodontists (2%), the questionable preference of practitioners reporting ties, and the small number of responses for "other" all-ceramic systems, these categories were eliminated for the construction of Table 3.

The data summarized in Table 3 were then used to test differences between prosthodontists and general practitioners in preferences for all-ceramic systems. A chi-squared test of independence determined that there were differences in preferences between prosthodontists and general practitioners ($P = 0.004$). Specifically, a greater proportion of prosthodontists reported that they prefer Procera (Nobel Biocare) and In-Ceram (Vident), while a greater proportion of general dentists prefer OPC (Jeneric Pentron). The most popular all-ceramic system for both prosthodontists and general practitioners is Empress (Williams/Ivoclar). Both prosthodontists (44%) and general dentists (43%) have a strong preference for that system.

The average percentage of time that each all-ceramic system is reportedly used by the practitioners was also calculated for prosthodontists and general practitioners (Table 4). Empress was again identified as the most popular all-ceramic system. The average frequency of use of each all-ceramic system reported by the prosthodontists and general dentists was similar to the trends noted in the all-ceramic system preferences.

Because of the amount and complexity of information, the restoration of access openings through complete-coverage restorations is detailed in separate tables for each crown type. Because of the low response by all practitioner groups in the use of glass-ionomer cement (less than 8%), the last 2 columns were integrated into 1 category in the tables of material preference in order to show a clinically and statistically relevant response.

Tables 5 and 6 show the preferred restorative material for access openings through gold crowns and the average frequency of use for each restorative material respectively. Both the preferred restorative material and the percentage of time that the restorative materials are used show a similar distribution with respect to practitioner type. A chi-squared test of independence

TABLE 5 Preferred restorative material for access openings through gold crowns*

| Practitioner type | Response rate | Amalgam | Amalgam and bonding agent | Resin composite | Other |
|-------------------|---------------|---------------|---------------------------|-----------------|--------------|
| Endodontists | 78% | 33% (52/157) | 38% (59/157) | 11% (18/157) | 18% (28/157) |
| Prosthodontists | 93% | 35% (57/163) | 36% (59/163) | 24% (39/163) | 5% (8/163) |
| General dentists | 89% | 30% (45/148) | 32% (47/148) | 32% (47/148) | 6% (9/148) |
| All practitioners | 86% | 33% (154/468) | 35% (165/468) | 22% (104/468) | 10% (45/468) |

*Frequencies given are only for practitioners who showed a clear preference for a particular restorative material.

TABLE 6 Frequency of use of materials in access openings through gold crowns

| Practitioner type | Response rate | Frequency of use | | | | |
|-------------------|---------------|------------------|---------------------------|-----------------|----------------------|-------|
| | | Amalgam | Amalgam and bonding agent | Resin composite | Glass-ionomer cement | Other |
| Endodontists | 79% | 31.9% | 37.4% | 12.6% | 3.6% | 14.5% |
| Prosthodontists | 96% | 33.7% | 36.8% | 24.3% | 2.6% | 2.6% |
| General dentists | 96% | 28.6% | 31.5% | 32.8% | 2.2% | 5.3% |
| All practitioners | 90% | 31.4% | 35.3% | 23.2% | 2.8% | 7.4% |

showed a significant difference in material preference ($P < 0.0001$): A large proportion of endodontists stated a preference for "other" restorative materials than the ones listed. This response among endodontists represented restoration with Cavit (ESPE) or other similar restorative measures. When the material preferences of prosthodontists and general practitioners were compared with a chi-squared test of independence, no statistically significant differences in material preference were discerned ($P = 0.414$). The most popular materials for restoring access openings through gold crowns are amalgam alone and amalgam combined with a bonding agent.

Tables 7 and 8 show the preferred restorative material for access openings through noble alloy crowns and the average frequency of use for each restorative material, respectively. Both the preferred restorative material and the percentage of time that the restorative materials are used show a similar distribution with respect to practitioner type. A chi-squared test of independence again showed significant difference in material preference ($P < 0.0001$); a large proportion of endodontists again stated a preference for restorative materials other than the ones listed. As before, the endodontists' responses corresponded to restoration with Cavit or a similar provisional measure for restoring the access opening, such as zinc oxide-eugenol provisional material or TERM (Dentsply). When the material preferences of prosthodontists were compared to those of general dentists with a chi-squared test, no significant differences were found ($P = 0.177$). The

most popular methods of restoring access openings through noble alloy crowns for all practitioner types are amalgam alone and amalgam combined with a bonding agent.

Tables 9 and 10 show the preferred restorative material for access openings through porcelain-fused-to-gold crowns and the average frequency of use of each restorative material, respectively. Both the preferred restorative material and the percentage of time that the restorative materials are used show a similar distribution with respect to practitioner type. A chi-squared test of independence revealed a statistically significant difference in material preference ($P < 0.0001$); a larger proportion of endodontists than prosthodontists and general dentists again stated a preference for restorative materials other than the ones listed. When the material preferences of prosthodontists were compared to those of general dentists, no statistically significant differences were found ($P = 0.563$). The most popular restorative material for restoring access openings in porcelain-fused-to-gold crowns for all practitioner types is resin composite. This contrasts with the results for both types of all-metal crowns, for which amalgam alone and amalgam with a bonding agent are the preferred restorative materials.

Tables 11 and 12 show the preferred restorative material for access openings through porcelain-fused-to-noble metal crowns and the average frequency of use of each restorative material, respectively. Both the preferred restorative material and the percentage of time that the restorative materials are used show a

TABLE 7 Preferred restorative material for access openings through noble alloy crowns*

| Practitioner type | Response rate | Amalgam | Amalgam and bonding agent | Resin composite | Other |
|-------------------|---------------|---------------|---------------------------|-----------------|--------------|
| Endodontists | 77% | 32% (50/155) | 37% (57/155) | 13% (20/155) | 18% (28/155) |
| Prosthodontists | 90% | 34% (54/157) | 39% (62/157) | 23% (36/157) | 3% (5/157) |
| General dentists | 85% | 31% (44/141) | 31% (44/141) | 32% (45/141) | 6% (8/141) |
| All practitioners | 83% | 33% (148/453) | 36% (163/453) | 22% (101/453) | 9% (41/453) |

*Frequencies given are only for practitioners who showed a clear preference for a particular restorative material.

TABLE 8 Frequency of use of materials in access openings through noble alloy crowns

| Practitioner type | Response rate | Frequency of use | | | | |
|-------------------|---------------|------------------|---------------------------|-----------------|----------------------|-------|
| | | Amalgam | Amalgam and bonding agent | Resin composite | Glass-ionomer cement | Other |
| Endodontists | 79% | 31.4% | 36.1% | 13.7% | 3.6% | 14.6% |
| Prosthodontists | 92% | 33.2% | 39.8% | 23.4% | 2.0% | 1.3% |
| General dentists | 92% | 28.7% | 31.5% | 32.8% | 2.5% | 4.8% |
| All practitioners | 87% | 31.1% | 35.9% | 23.1% | 2.7% | 6.9% |

TABLE 9 Preferred restorative material for access openings through porcelain-fused-to-gold crowns*

| Practitioner type | Response rate | Amalgam | Amalgam and bonding agent | Resin composite | Other |
|-------------------|---------------|--------------|---------------------------|-----------------|--------------|
| Endodontists | 73% | 17% (25/148) | 18% (26/148) | 45% (66/148) | 21% (31/148) |
| Prosthodontists | 85% | 16% (23/148) | 20% (29/148) | 59% (88/148) | 5% (8/148) |
| General dentists | 81% | 11% (15/134) | 16% (22/134) | 67% (90/134) | 5% (7/134) |
| All practitioners | 79% | 15% (63/430) | 18% (77/430) | 57% (244/430) | 11% (46/430) |

*Frequencies given are only for practitioners who showed a clear preference for a particular restorative material.

TABLE 10 Frequency of use of materials in access openings through porcelain-fused-to-gold crowns

| Practitioner type | Response rate | Frequency of use | | | | |
|-------------------|---------------|------------------|---------------------------|-----------------|----------------------|-------|
| | | Amalgam | Amalgam and bonding agent | Resin composite | Glass-ionomer cement | Other |
| Endodontists | 78% | 17.5% | 17.8% | 43.9% | 5.0% | 16.4% |
| Prosthodontists | 96% | 15.5% | 19.4% | 58.4% | 2.4% | 3.7% |
| General dentists | 94% | 11.7% | 18.0% | 62.7% | 3.2% | 4.6% |
| All practitioners | 89% | 14.9% | 18.4% | 55.1% | 3.5% | 8.2% |

similar distribution with respect to practitioner type. A chi-squared test of independence showed a significant difference in material preference ($P < 0.0001$). A large proportion of endodontists again stated a preference for restorative materials other than the ones listed. When the material preferences of prosthodontists were compared to those of general dentists with a chi-squared test, no statistically significant differences

were found ($P = 0.870$). For all practitioner types, the most popular restorative material for restoring access openings in porcelain-fused-to-noble metal crowns is composite.

Tables 13 and 14 show the preferred restorative material for access openings through all-ceramic crowns and the average frequency of use of each restorative material, respectively. Both the preferred restorative

TABLE 11 Preferred restorative material for access openings through porcelain-fused-to-noble alloy crowns*

| Practitioner type | Response rate | Amalgam | Amalgam and bonding agent | Resin composite | Other |
|-------------------|---------------|--------------|---------------------------|-----------------|--------------|
| Endodontists | 73% | 16% (23/148) | 16% (23/148) | 47% (70/148) | 21% (31/148) |
| Prosthodontists | 82% | 14% (20/144) | 17% (25/144) | 63% (91/144) | 6% (8/144) |
| General dentists | 83% | 12% (17/137) | 15% (20/137) | 68% (93/137) | 5% (7/137) |
| All practitioners | 79% | 14% (60/428) | 16% (68/428) | 59% (254/428) | 11% (48/428) |

*Frequencies given are only for practitioners who showed a clear preference for a particular restorative material.

TABLE 12 Frequency of use of materials in access openings through porcelain-fused-to-noble alloy crowns

| Practitioner type | Response rate | Frequency of use | | | | |
|-------------------|---------------|------------------|---------------------------|-----------------|----------------------|-------|
| | | Amalgam | Amalgam and bonding agent | Resin composite | Glass-ionomer cement | Other |
| Endodontists | 77% | 15.9% | 16.0% | 46.9% | 5.8% | 15.5% |
| Prosthodontists | 91% | 13.8% | 18.5% | 62.2% | 1.9% | 4.2% |
| General dentists | 95% | 13.0% | 16.4% | 62.8% | 3.3% | 4.5% |
| All practitioners | 87% | 14.2% | 16.9% | 57.4% | 3.7% | 8.0% |

TABLE 13 Preferred restorative material for access openings through all-ceramic crowns*

| Practitioner type | Response rate | Amalgam | Amalgam and bonding agent | Resin composite | Other |
|-------------------|---------------|-------------|---------------------------|-----------------|--------------|
| Endodontists | 71% | 8% (11/143) | 12% (17/143) | 56% (80/143) | 24% (35/143) |
| Prosthodontists | 83% | 5% (7/146) | 11% (16/146) | 79% (115/146) | 5% (8/146) |
| General dentists | 85% | 2% (3/141) | 10% (14/141) | 83% (117/141) | 5% (7/137) |
| All practitioners | 79% | 5% (21/430) | 11% (47/430) | 73% (312/430) | 12% (50/430) |

*Frequencies given are only for practitioners who showed a clear preference for a particular restorative material.

TABLE 14 Frequency of use of materials in access openings through all-ceramic crowns

| Practitioner type | Response rate | Frequency of use | | | | |
|-------------------|---------------|------------------|---------------------------|-----------------|----------------------|-------|
| | | Amalgam | Amalgam and bonding agent | Resin composite | Glass-ionomer cement | Other |
| Endodontists | 74% | 8.0% | 12.3% | 54.9% | 7.4% | 17.4% |
| Prosthodontists | 86% | 5.0% | 10.1% | 78.5% | 2.7% | 4.0% |
| General dentists | 87% | 2.2% | 10.6% | 80.9% | 2.4% | 4.1% |
| All practitioners | 82% | 5.1% | 11.0% | 70.6% | 4.2% | 8.6% |

material and the percentage of time that the restorative materials are used show a similar distribution with respect to practitioner type. A chi-squared test of independence showed a significant difference in material preference ($P < 0.0001$). A large proportion of endodontists again stated a preference for restorative materials other than the ones listed. When the material preferences of prosthodontists were compared to those

of general dentists with a chi-squared test, no statistically significant differences were found ($P = 0.630$). The most popular restorative material for restoring access openings in all-ceramic crowns is resin composite for all practitioner types.

DISCUSSION

The importance of leakage and the restoration of endodontically accessed complete-coverage crowns are supported by the fact that the survey's question addressing restoration had a 98.5% response. General practitioners (93%) always or frequently place permanent restorations significantly more often than do endodontists (61%) and prosthodontists (75%). The latter 2 groups seemed more cautious when choosing to place a final restoration.

Empress was identified as the most popular ceramic system among both prosthodontists and general practitioners; prosthodontists use Empress 42% of the time and general dentists use Empress 38% of the time. This information will be used to identify which system to use in an *in vitro* study that will involve the restoration of all-ceramic crowns with endodontic access openings.

The findings regarding the materials selected for restoration of the various types of complete-coverage crowns were diverse. For gold crowns with access openings, amalgam and amalgam with a bonding agent were identified as the most common restorative materials (68%). This information seems significant because amalgam alone or with varnish has been shown to leak in different areas at the restoration-tooth interface.¹⁴⁻¹⁶ The results of the survey tend to support the use of amalgam with a bonding agent as a final restoration (35%). Since the original use of adhesive restorations in dentistry by Buonocore et al,¹⁷ the use of bonding agents has enhanced the techniques of chemical adhesion by materials that lack such properties. Although the nature of the bond between resin and amalgam is not clear, it is believed that adhesive resin liners reduce leakage more effectively than do cavity varnishes.¹⁸⁻²⁰ The combination of amalgam and bonding agent is thought to control marginal leakage and to produce retentive bonds between dentin and amalgam; however, no evidence-based data have been published about the bond between the crown restoration and amalgam with bonding agent.

The respondents to this survey identified composite restorations as their material of choice for all types of crowns involving porcelain (63%) and more significantly for restoration of all-ceramic crowns (75%). The restoration of ceramic artificial crowns, whether all-ceramic or porcelain-fused-to-metal, involves an esthetic component as well as the challenge of controlling leakage. Among the specifications for the ideal dentin bonding agent, not only the esthetics of the resin composite but also the minimization of leakage at the margins of restorations and the prevention of recurrent caries and marginal staining are of concern. The idea that volumetric changes of the resin materi-

als hinder the retention of this material to the tooth is an obsolete dogma with the improvement in performance over 4 generations of bonding. This improvement has resulted from greater knowledge of the permeability of the dentin surface,²¹ the effect over the dentin collagen complex,²² and the wettability of the dentin substrate.²³

Endodontists indicated they used more materials, such as Cavit, Zinc oxide-eugenol temporary cement, TERM, and glass-ionomer cement, as provisional restorations placed before the patient was returned to the referring practitioner. The endodontist relies on an assessment of the marginal integrity of the crown to be provided prior to the selection of a final restoration by the restorative dentist.

Outcomes of NSRCT through an existing complete-coverage restoration have been investigated in terms of comparative strength and retention of the crowns when various materials were used to restore the access cavity. While it was concluded that the amalgam with the bonding agent would maintain the integrity of the coronal restoration, the leakage factor was not considered.²⁴⁻²⁶ Whether or not the seal of the complete-coverage restoration, both at the crown-tooth margin and the endodontic access opening-restoration margin, remains intact over time and the influence of various restorative materials used for this purpose remain to be clarified.

Contamination of dentin with saliva and its associated bacterial component through leakage has a detrimental effect on pulpal and periapical tissues.²⁷⁻³¹ Leakage around the margin of a cast restoration is a problem that is extremely difficult to assess clinically and frequently extends toward the pulp through the dentinal tubules. The importance of the integrity of the interface between the access restoration and crown therefore cannot be understated.³

There are a significant number of complete-coverage crowns that require NSRCT and whose access openings are restored with materials that have not been evaluated in these specific conditions. The identification of which material or materials furnish the optimal result in the prevention of coronal leakage will ensure the success of nonsurgical root canal therapy.

The old adage "it worked for me for decades" is no longer acceptable in a scientific discipline that demands the use of evidence-based techniques. It is essential that clinical decision-making involves assessment of hard evidence to assure optimum patient outcomes.³² The need for a better understanding of the current materials used in dentistry demands a more concise and thorough evaluation of its components and the properties that are attributed to these materials. This would provide present and

future generations with the most contemporary bases for continued developments of each specialty and in general, dentistry.

CONCLUSION

Survey questions regarding the restoration of access cavities after nonsurgical root canal treatment through complete-coverage crowns revealed the following:

1. General practitioners permanently restore the endodontic access of complete-coverage crowns after nonsurgical root canal therapy more frequently than do prosthodontists and endodontists.
2. Among all practitioners, amalgam alone and amalgam with bonding agents are the materials of choice for restoring noble and high-noble complete-coverage crowns.
3. Resin composite restorations are used when porcelain is involved, which adds an esthetic component to the final restoration.
4. Empress was identified as the most popular all-ceramic system among restorative dentists.
5. Although prosthodontists were guarded when placing a final restoration in an accessed complete-coverage crown, the endodontist was more prone to place other materials, such as glass-ionomer cement, Cavit (ESPE), TERM (Dentsply), and IRM (Dentsply), as provisional restorations in the access cavity following nonsurgical root canal treatment.

From the data collected in this survey, an *in vitro* study is indicated to provide evidence-based parameters for the determination of materials that will effectively seal endodontic access openings in crowned teeth.

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REFERENCES

1. Wathen WF. Evidence-based dentistry: Is it worth changing our approach to practice? [editorial]. *Quintessence Int* 1998;29:757.
2. Grace M. The relevance of evidence. *Quintessence Int* 1998;29:802-806.
3. Oliver CM, Abbot PV. Entrapped air and its effects on dye penetration of voids. *Endod Dent Traumatol* 1996;7:135-138.

4. Gutmann JL. Clinical, radiographic, and histologic perspectives on success and failure in endodontics. *Dent Clin North Am* 1992;36:379-392.
5. Goldman M, Laosonthorn P, White RR. Microleakage—Pull crowns and dental pulp. *J Endod* 1992;18:473-475.
6. Madison S, Wilcox LR. An evaluation of coronal microleakage in endodontically-treated teeth. Part III. *In vivo* study. *J Endod* 1988;14:455-458.
7. Ray H, Trope M. Periapical status of endodontically treated teeth in relation to the quality of the root filling and the coronal restoration. *Int Endod J* 1995;28:12-18.
8. Magura ME, Kafrawy AH, Brown CE Jr, Newton CW. Human saliva coronal microleakage in obturated root canals: An *in vitro* study. *J Endod* 1991;17:324-331.
9. Saunders WP, Saunders EM. Assessment of leakage in the restored pulp chamber of endodontically treated multi-rooted teeth. *Int Endod J* 1990;25:28-35.
10. Wu M-K, Wessellink PR. Endodontic leakage studies reconsidered. Part I. Methodology, application and relevance. *Int Endod J* 1993;26:37-45.
11. Saunders WP, Saunders EM. Coronal leakage as a cause of failure in root canal therapy: A review. *Endod Dent Traumatol* 1994;10:105-108.
12. Gutmann JL, Dumsha TC, Loydhal PE, Hovland EJ. Problem Solving in Endodontics. Prevention, Identification, and Management, ed 3. St Louis: Mosby; 1997:344.
13. Trautmann G, Gutmann JL, Nunn ME, Witherspoon DE, Shulman JD. Restoring teeth that are endodontically treated through existing crowns. I. Survey of pulpal status on access. *Quintessence Int* 2000;31:715-718.
14. Going RE, Massler M, Dute HL. Marginal penetration dental restorations by different radioactive isotopes. *J Dent Res* 1960;39:273-284.
15. Wei SHY, Ingram MJ. Analysis of the amalgam-tooth interface using the electron microprobe. *J Dent Res* 1969;48:317-320.
16. Kidd EAM. Microleakage in relation to amalgam and composite restorations. *Br Dent J* 1976;141:305-310.
17. Buonocore M, Wileman W, Brudevold F. A report on a resin composition capable of bonding to human dentin surfaces. *J Dent Res* 1956;35:846-851.
18. Pashley EL, Comer RW, Parry EE, Pashley DH. Amalgam buildups: Shear bond strength and dentin sealing properties. *Oper Dent* 1991;16:82-89.
19. Varga J, Matsumura H, Masuhara E. Bonding and amalgam filling to tooth cavity with adhesive resin. *Dent Mater* 1986;5:158-164.
20. Staninec M, Holt M. Bonding of amalgam to tooth structure: Tensile adhesion and microleakage tests. *J Prosthet Dent* 1988;59:397-402.
21. Pashley DH, Pashley EL. Dentin permeability and restorative dentistry: A status report for the *American Journal of Dentistry*. *Am J Dent* 1991;4:5-9.
22. Kanca J III. Resin bonding to wet substrate. I. Bonding to dentin. *Quintessence Int* 1992;23:39-41.
23. Eick JD, Robinson SJ, Chappell RP, Cobb CM, Spencer P. The dentin surface: Its influence on dentinal adhesion. Part II. *Quintessence Int* 1993;24:571-582.
24. McMillan AP, Himel VT, Sarkar NK. An *in vitro* study of the effect endodontic access preparation and amalgam restoration have upon incisor crown retention. *J Endod* 1990;16:269-272.

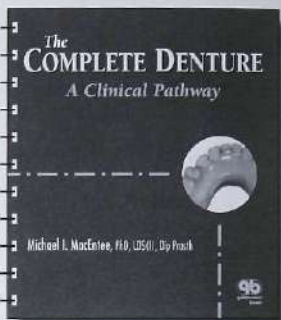
25. Mulvey PJ, Abbott PV. The effect of endodontic access cavity preparation and subsequent restorative procedures on molar crown retention. *Aust Dent J* 1996;41:134-139.
26. Yu YC, Abbott PV. The effect of endodontic access cavity preparation and subsequent restorative procedures on incisor crown retention. *Aust Dent J* 1994;39:247-251.
27. Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. *Oral Surg Oral Med Oral Pathol* 1965;20:340-349.
28. Bergenholtz GJ, Lindhe J. Effect of soluble plaque factors on inflammatory reactions in the dental pulp. *Scand J Dent Res* 1975;83:153-158.
29. Bergenholtz GJ. Effects of bacterial products on inflammatory reactions in the dental pulp bacteria. *Scand J Dent Res* 1977;85:122-129.
30. Bergenholtz GJ. Inflammatory response of the dental pulp to bacterial irritation. *J Endod* 1981;7:100-104.
31. Bergenholtz GJ, Cox CG, Loesche WJ, Syed SA. Bacterial leakage around dental restorations: Its effect in the dental pulp. *J Oral Pathol Med* 1982;11:439-450.
32. Nevins M. Keynote Address—1996 Workshop in Periodontics. *Ann Periodontol* 1996;1:10-13.

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