Survey of the provision of crowns by dentists in Ireland

Précis
This survey shows that there is a high use of aesthetic crowns and new materials by Irish dentists, but there is scope for improvement in areas of impression technique, shade taking and laboratory communication.

Abstract
Statement of the problem: The literature is limited on the detailed description of the practice of Irish general dentists in the provision of crowns.
Purpose of the study: To review the provision of crowns by dentists in Ireland and identify opportunities for improving current clinical practices.
Materials and methods: A questionnaire was posted to 500 general dentists selected randomly from the Irish Dental Register and 150 responded. Twenty-three laboratories used by these dentists were subsequently surveyed.
Results: The Vita Shade Guide was the most commonly used shade guide. Crowns were mainly fabricated using porcelain bonded to metal (51%) followed by all-ceramic (42%) and gold (5%). Plastic Solo trays were the preferred tray for impressions and the laboratory prescription form was the primary means of dentist–technician communication. Dentists and technicians have different preferences for impression trays, impression materials and bite registration, while a significant percentage of dentists (18%) admitted to not disinfecting impressions. Resin or resin-based cements are the preferred means of crown cementation.
Conclusions: This study suggests that the accuracy of restorations could be improved by: adopting a multi-technique approach to shade taking; replacing Solo trays with metal or custom trays for impression-taking; upgrading of the putty-wash technique by using a custom tray with a 2mm spacer and a heavy-bodied/light-bodied silicone; and, using a two-cord retraction technique, perhaps in combination with electrosurgery or soft tissue laser, to improve marginal accuracy where indicated.

Introduction
The general dental practitioner has an increasingly broad range of choice when it comes to the provision of crowns, as recent years have seen developments in materials, technology and clinical techniques.¹ These developments have been accompanied by increasing patient expectations for more aesthetically pleasing prostheses and restorations, particularly in the anterior region.² All of these place greater demands on the dentist and in turn necessitate higher levels of teamwork with specialists and the laboratory technician. The demand for aesthetics and advances in materials have greatly increased the range of tooth-like crowns. Each type of crown may have specific requirements in terms of tooth preparation design, treatment of the fit surface, luting technique and shade taking, according to the manufacturer’s specifications. As a result, the aesthetic crown places a higher burden on the dentist to learn new techniques and often requires the use of additional specialised materials and equipment.

The literature is limited on the detailed description of the practice of general dentists regarding the provision of crowns, particularly given the recent availability of all-
ceramic materials. Previous studies\textsuperscript{3,4} have shown communication from dentists to the laboratory to be poor. The purpose of this study is to consider the effect of increased demand for aesthetic restorations on prescription patterns, shade taking, use of new materials and communication with laboratories. The objectives are to collect data on: current clinical practices; how dentists and laboratories communicate; differences in perception between the two groups; and, how the situation in Ireland compares with other countries.

Materials and methods
In April 2008 a questionnaire (Appendix A) was posted to 500 general dentists chosen at random from the Irish Dental Register and 150 responded. Twenty-three laboratories used by these dentists were subsequently surveyed. The Irish Dental Council provided a CD-ROM containing the list of all dentists registered to practice dentistry in Ireland as of March 18, 2008. The list contained a total of 2,523 dentists and this was reduced to 1,969 by excluding those with additional registered qualifications. The list was further reduced to 1,873 by excluding those dentists with addresses outside Ireland. A random number generator was used to select 500 dentists at random from this list. Each of the 500 dentists was sent a cover letter, the questionnaire and a stamped addressed envelope. The letter invited each dentist to return the questionnaire in the stamped addressed envelope and, as an incentive, offered the dentist the option of receiving a summary of the results of the survey.

The questionnaire sent to dentists asked for the details of the primary laboratory used for crowns. A total of 52 laboratories were mentioned in the questionnaires returned by the dentists. Contact by telephone was attempted for all those laboratories where telephone numbers were provided or where the laboratory telephone number could be obtained by research. The laboratories mentioned most by dentists were prioritised and greatest effort was made to obtain responses from these laboratories. A covering letter was created to invite each laboratory to return the questionnaire in a stamped addressed envelope and offered the laboratory the option of receiving a summary of the results of the survey.

Each laboratory was contacted by telephone and offered the option of completing the questionnaire in Appendix B on the telephone, by email, by post or by completing an online version of the questionnaire created using ViewletQuiz\textsuperscript{,} version 3.0.2, Qarbon (www.qarbon.com).

Questionnaires
The dentist questionnaire requested data concerning the current practice of dentists in respect of crowns, requested demographic data, and contained questions on factors affecting crown selection, use of different crown types and cements, rating of primary crown laboratory, use of tray and impression materials, shade, retraction techniques, decontamination of impressions and communications with laboratories. The laboratory questionnaire contained questions on communications with dentists, rating of information and impressions received from dentists, decontamination of impressions, information missing on instructions from dentists, and rating of various aspects of their crown work.

Results
The total response rate from dentists was 30\% (n=150). This included 30 dentists who did not provide crowns, comprising the following groups: dentists no longer at the address (n=2); dentists not providing crowns (n=2); retired dentists (n=8); and, dentists employed within the health service and not providing crowns (n=17). Of the responses, 28\% (n=33) were from female dentists and 72\% (n=86) from male dentists, while one dentist did not specify gender.

The age profile of the dentists returning a questionnaire is shown in Figure 1. The response was dominated by 35\% (n=42) of dentists in the 31 to 40 age group and 30\% (n=36) of dentists in the 41 to 50 age group.

The questionnaire posted to dentists asked them to provide details of the laboratory that they use as their primary source of crowns. A total of 85\% (n=102) of dentists supplied details of their primary crown laboratory. A total of 52 laboratories were mentioned by dentists. Questionnaires were completed by 44\% (n=23) of laboratories, including the 12 most mentioned laboratories. A total of 96\% (n=115) of respondents provided details of the type of shade-taking method they used. The classic Vita Shade Guide is the shade guide most commonly used, with 87\% (n=100) of respondents mentioning it (Figure 2). The use of the VITA 3D Shade Guide lags...
behind at just 34% (n=39). Although dentists with higher placement of crowns (41+ crowns) are the largest user group of the VITA 3D shade guide with 49% (n=27) penetration, there is no discernible pattern of usage by number of crowns placed, age or gender. Laboratories were asked what shade guide best served their purpose and 22 provided a reply, with 77% (n=17) choosing the Vita Shade Guide and 18% (n=4) choosing the Vita 3D. The study indicates that the Vita Classic shade is the most predominant shade guide in use by both dentists and laboratories.

A total of 96% (n=115) of respondents ranked six criteria in order of their influence on the selection of crown types on a scale of 1 to 6. The ranking was analysed in terms of first preference by counting the number of times that a factor was ranked as 1 by a dentist. The results are summarised in Figure 3.

Dentists were asked to provide details on the number of crowns that they placed in the last 12 months, how this was distributed across the different types of crowns, and what cements they used in each case. A total of 98% (n=118) of dentists provided a reply on crowns placed. The data on crowns placed were also accumulated for each dentist to determine the range of total numbers of crowns placed by dentists. A histogram of the results is plotted in Figure 4, which shows that 52% place 40 crowns or fewer per annum. The distribution of number of crowns placed by male and female dentists is shown in Figure 5.

Bonded crowns (51%) continue to be the most frequently placed crowns, though the more recent ceramic crowns (42%) are also very popular by a long margin over gold, Captek™ and composite reinforced crowns (Figure 6).

A total of 88% (n=105) of dentists provided information on the cements used with crowns. Resin cements were used for a broader range of crowns than any other cement and appear to be the cement of choice for most crowns, as shown in Table 1, although no dentist mentioned their use with gold crowns. Glass ionomer and zinc phosphate cements continue to be used by a sizeable number of dentists. A total of 50% (n=53) of dentists use one cement alone; 10 of these specified just one crown type but the remaining 43 used the same cement for more than one type of crown. With the exception of white gold, resin cements were the most frequently used cements for all crowns.

A total of 98% (n=118) of dentists replied to the question asking whether gingival retraction was used and what techniques were used, with 95% (n=112) of the replies stating that gingival retraction was used. Figure 7 shows the numbers of dentists using the six retraction methods mentioned in the survey. Copper rings were also offered as an option but no dentist indicated that they used this technique. The dentists’ use of trays (Figure 8) is at odds with the laboratories’ preferred impression tray. Laboratories were asked which tray they
preferred in order to achieve optimal crown accuracy. All 23 laboratories answered this question. A total of 57% (n=13) preferred the metal tray, 35% (n=8) the custom tray, 4% (n=1) the Doric Tray, and just 4% (n=1) chose the Plastic Solo tray. Figure 9 summarises the dentists’ replies to the question about their use of impression materials. Reversible hydrocolloid was offered as an impression material but no dentist indicated that it was used. The question regarding alginate was in relation to its use to record opposing arches. A total of 93% (n=112) of respondents answered the question asking about their use of custom trays. The replies are summarised in Figure 10; 14% (n=16) indicated that they never use custom trays. Laboratories were asked how many dentists used custom trays. Twenty-two laboratories answered and reported that the number of dentists providing custom trays was 8% (nine said 1% and two said nil). Laboratories were asked to identify which combination of tray and impression material caused them the most difficulty. A total of 91%
(n=21) responded. Table 2 lists the items causing them most difficulty plus the number of laboratories mentioning each item. A total of 98% (n=118) of dentists answered the question on decontamination. Of these, 18% (n=21) replied that they do not decontaminate. The laboratories were asked to indicate what percentage of impressions received from dentists they considered to be decontaminated. All 23 laboratories replied and the results are shown in Figure 11. All the laboratories confirmed that they decontaminate the impressions before models are poured.

Dentists were asked to specify which of three methods they used to record the occlusion and identify those that applied. A total of 98% (n=118) answered the question and the results indicated that the wax bite and occlusal bite registration paste were the most common methods at 65% (n=77) and 64% (n=75), respectively. The facebow method usage was much lower at 21% (n=25).

The laboratories were also asked to rate the general bite communication received for each method (on a scale of 1-5, 5 being excellent). Twenty-two laboratories responded and the results were shown in Table 3. Laboratories were asked to indicate the percentage of dentists using each of the three methods for communicating crown shape and size. Twenty-two laboratories responded and all said that written instructions were used, 55% (n=12) said drawings were provided and 41% (n=9) said that wax-ups were used (Figure 13). Laboratories were asked to give the percentage of crown laboratory dockets that were missing information in four specific cases and the results are shown in Table 3.

The survey indicates gender difference in several aspects of crown restorations. Female dentists reported greater use of the Plastic Solo tray, with 88% (n=28) indicating use of this type of tray compared to 73% (n=58) of their male counterparts. This was found to be similar to other countries. A gender difference was observed in the survey results for decontamination with 88% (n=29) of female dentists decontaminating compared to just 81% (n=68) of male dentists. Female dentists indicated greater use of the wax bite (73%, n=24).

![FIGURE 11: Laboratories’ perception of disinfected impressions.](image1)

![FIGURE 12: How dentists communicate crown form.](image2)

![FIGURE 13: Laboratory receipt of information about crown shape and size.](image3)

### Table 2: Trays and impression materials causing most difficulty for laboratories.

<table>
<thead>
<tr>
<th>Trays and impression materials</th>
<th>Number of laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solo and two-stage impression material</td>
<td>6</td>
</tr>
<tr>
<td>Triple trays and two-stage impression material</td>
<td>4</td>
</tr>
<tr>
<td>Solo and silicone</td>
<td>2</td>
</tr>
<tr>
<td>Impregum and metal</td>
<td>2</td>
</tr>
<tr>
<td>Plastic and two-stage</td>
<td>1</td>
</tr>
<tr>
<td>Heavy body putty</td>
<td>1</td>
</tr>
<tr>
<td>Plastic Solo and monophase impression material</td>
<td>1</td>
</tr>
<tr>
<td>Custom tray with two-stage</td>
<td>1</td>
</tr>
<tr>
<td>Dual arch and Solo tray</td>
<td>1</td>
</tr>
<tr>
<td>Plastic trays</td>
<td>1</td>
</tr>
<tr>
<td>Impression compound on an opposing arch</td>
<td>1</td>
</tr>
</tbody>
</table>

![Table 3: Laboratory forms with missing information.](image4)

<table>
<thead>
<tr>
<th>Laboratory forms with missing information</th>
<th>Percentage of laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab dockets with insufficient information</td>
<td>28%</td>
</tr>
<tr>
<td>Lab dockets that require contact with dentist for additional information</td>
<td>25%</td>
</tr>
<tr>
<td>Lab dockets with insufficient information on sites to be covered with porcelain</td>
<td>43%</td>
</tr>
<tr>
<td>Lab dockets specifying the percentage of gold (for gold crowns)</td>
<td>36%</td>
</tr>
</tbody>
</table>
than male dentists (62%, n=53). A greater proportion of female dentists (48%, n=16) used the two-cord technique than male dentists (38%, n=32). Male dentists reported higher use of electrosurgery (23%, n=19) and Expasyl (13%, n=11) than female dentists (15%, n=5 and 6%, n=2, respectively). The small sample size of female dentists in the completed questionnaires would caution against making inferences about the total population of dentists.

Discussion
The effective return rate, comprising dentists in general practice in Ireland providing crowns, was 24% (n=120). The response rate of 150 for a total population size of 1,873 represents a sampling fraction of 8%, giving a margin of error of 7.7% for a confidence level of 95%, assuming a response distribution of 50%. The response rate of the survey (30%) may have been influenced by the length of the questionnaire (19 detailed questions and up to 102 separate items of data) and the lack of follow-up reminder (telephone call or letter). A higher response rate (44%) was achieved from laboratories, which may have been influenced by the follow-up telephone call, greater choice in completing the questionnaire (mail back the questionnaire, complete online or complete the questionnaire by means of telephone interview), and less complex questionnaire (18 questions and up to 46 items of data). There is the possibility that the limited response rate will limit the conclusions drawn from the data.

The literature often specifies clinical considerations (such as strength), aesthetics and cost as being the primary factors affecting the choice of crowns.5 This survey suggests that there are other significant factors that influence the selection of type of crown. Whereas clinical considerations and aesthetics remain significant factors, dentist preference and customer preference are indicated as having higher significance than cost. This finding is of particular importance, as patient involvement and agreement in treatment planning has become a necessity to meet the increase in medico-legal demands, especially where anterior teeth are concerned.

The most popular cement for dentists in the survey was RelyX Unicem (3M), which is encouraging as several studies have found that resin cements achieve the best bond strength and marginal integrity (3M), which is encouraging as several studies have found that resin cements achieve the best bond strength and marginal integrity. Moreover, the use of dental adhesives for the range of cements significantly increases their bond strength.

Decontamination of impressions as perceived by technicians and the author of the study postulated that the level was likely to be in excess of 10%. Decontamination of impressions by dentists is a serious issue for laboratories and all expressed concern that they were provided with insufficient information on the contamination state of the impressions. Laboratories did not know with absolute certainty which of the impressions from dentists were decontaminated or which ones were potentially contaminated with an infectious disease. In the absence of written confirmation, laboratories can only make an assessment of decontamination by a visible inspection of the impression and though no laboratory reported receiving heavily contaminated impressions, the majority report receiving some impressions with minimal contamination. It is disappointing that decontamination of impressions is not universally performed given the evidence in the literature about the potential transmission of infection to the laboratory.9,10,11

The survey indicates that there are practices in common use by dentists that cause difficulty for laboratories when they attempt to fabricate crowns based on the impressions, occlusal records and information supplied by dentists. The survey indicates that plastic trays are the tray of choice for most dentists, with many using the Plastic Solo tray for much of their crown impression work. One study12 showed that these trays lead to inaccuracies when used with siloxanes. This use of various types of tray is similar to other countries,18,19,20,21 although a number of European countries predominantly use metal trays.17 A number of dentists also used dual-arch trays despite their potential inaccuracies, especially when used with heavy-bodied silicone material.23,24

The laboratories expressed a preference for monophase impression materials used in conjunction with metal or custom trays. This may be linked to the increased possibility of incurring inaccuracies by using the two-stage technique incorrectly. Polyvinylsiloxane material is the most accurate material but requires close attention to technique.25

A similar situation was reported for occlusal records, with dentists indicating that the wax-bite was the most common means by which they communicate occlusion to the laboratory and that the facebow was used infrequently. Laboratories considered the wax-bites received to be the least accurate of the occlusal records due to the inherent accuracy characteristics of the method, but also largely because dentists used too much wax.10,11,12 The excessive wax used caused diminished accuracy. Laboratories recognised the benefits of using a facebow, compared to no facebow, but the majority expressed the view that receiving greater numbers of facebows from dentists would not improve matters because facebows were not recorded adequately. Newer, simplified facebows such as the Kois facebow may provide a solution to the difficulty that seems to be commonplace with use of a facebow in general practice.33

The facebow allows the greatest accuracy to be achieved when mounting casts on an articulator and enables the axis of rotation of the articulator to replicate the transverse horizontal axis of the patient. Mounted diagnostic models aid occlusal analysis and treatment planning by assisting the dentist in identifying factors that are causing a functional problem and in visualising the changes required to achieve a desired aesthetic result. Observation of accurately mounted models enables...
the dentist to evaluate several occlusal factors, which can be difficult to see in vivo, such as the effect of anterior guidance on posterior discission, premature contacts, and signs of mobility and wear. Use of facebow and mounted diagnostic models are recommended where extensive restoration is planned and in the case of functional problems such as tooth wear, mobility, tender facial muscles or temporomandibular joint disorders.

During the telephone interviews with the laboratories many observed that crown margins were often poorly defined. The extent to which single cord gingival retraction is used may have a bearing on this since it may be less effective than the other retraction methods available. The requirement for accuracy is that a minimum of 0.2mm of polyvinylsiloxane is necessary to minimise distortion. The two-cord technique has been reported as providing greater accuracy.

The primary medium for communications between the dentist and the laboratory continues to be the laboratory docket, often supplemented by drawings/diagrams and less often by photographs. However, information is often missing from these dockets and the consequences of the missing data is a loss of time for the laboratory and perhaps a suboptimal crown as laboratories may not seek or receive the information that they require. Earlier studies have shown that communication between the dentist and laboratory was poor and it appears from this study that this continues to be the case.

Conclusion
The provision of crowns in Ireland is similar to the situation in other countries:
- the quality of impressions is problematic for fabrication of quality crowns;
- plastic trays are the preferred means of recording impressions by dentists;
- elastomeric impression materials are most commonly used;
- a significant percentage of dentists (18%) do not disinfect impressions;
- communication between dentists and laboratories is primarily through the laboratory prescription form, with a large proportion of these (25%) missing information;
- the specification of type of crown or alloy is often missing; and,
- the communication of the occlusal relationship is inadequate.

Based on the areas of concern identified in the survey, the following suggestions can be proposed based on currently available literature to improve the provision of crowns:

- Improve restoration accuracy through:
  - adoption of a multi-technique approach to shade taking;
  - replacement of Plastic Solo trays with metal, rigid plastic trays or custom trays for impression taking;
  - refinement of the dual stage putty-wash technique by using a custom tray with a 2mm spacer and a heavy-bodied/light-bodied silicone;
  - increased use of a facebow;
  - limiting the amount of bite registration paste to the inter-occlusal space and single-wafer wax in occlusal records. Not using any inter-occlusal recording medium unless it is indicated. Where records are indicated, the choice and clinical manipulation should be understood; and,
  - use of adequate retraction through a two-cord or other evidence-based technique.

- All items such as impressions, occlusal records and prostheses, which have been in a patient’s mouth, should be disinfected before being sent to the laboratory. The laboratory should also be informed so that a duplicate disinfection process is avoided.

- Indicate the known infectious state of the patient. Where the patient is known to have an infectious disease, state the nature of the condition on the laboratory prescription form and follow COSHH guidelines. To maintain patient confidentiality it may be appropriate to consider using a unique patient ID rather than a name on the form. In all other cases state that the patient is not known to have an infectious disease.

- Emphasise the importance of good communication skills with the dental technician.

References


