TITLE: Metal-Ceramic and Porcelain Dental Crowns: A Review of Clinical and Cost-Effectiveness

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CONTEXT AND POLICY ISSUES:

Dental ceramics are widely used to repair damaged teeth and restore mechanical properties. Metal, metal-ceramic, and porcelain materials may be used in the reconstruction. Ceramic crowns offer a more natural tooth appearance however they may be brittle, technique sensitive to polish, and abrasive to opposing teeth. Policy makers require information on the relative benefits, costs, and complications associated with different types of crown materials in order to support reimbursement decisions.

RESEARCH QUESTIONS:

1. What is the clinical-effectiveness of porcelain dental crowns compared to metal-ceramic dental crowns in terms of longevity, prognosis, and complications?

2. What is the cost-effectiveness of porcelain dental crowns compared to metal-ceramic dental crowns?

METHODS:

A limited literature search was conducted on key health technology assessment resources, including PubMed, The Cochrane Library (Issue 2, 2009), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, EuroScan, international health technology agencies, and a focused Internet search. The search was limited to English language articles published between 2004 and June, 2009. Filters were applied to limit the retrieval to health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, controlled clinical trials, observational studies, economic studies, and guidelines.
Studies were included if they assessed the longevity, prognosis, complications, or costs related to dental crowns in adults. The studies compared porcelain (ceramic, acrylic) crowns to metal-ceramic crowns and were either a systematic review, meta-analysis, health technology assessment, randomized controlled trial, controlled clinical trial, observational study, economic evaluation, or guideline. Studies that assessed only one type of crown (i.e.: did not have a comparator group drawn from the same population) were excluded.

HTIS reports are organized so that the higher quality evidence is presented first. Therefore, randomized controlled trials are reported before observational studies.

SUMMARY OF FINDINGS:

Our search identified one randomized controlled trial\(^1\) and two observational studies.\(^3,4\) One observational study also included a cost-effectiveness analysis however the results could not be used to answer the research question for this report.\(^1\) Two potentially relevant systematic reviews were identified but were excluded due to methodological issues (see appendix).\(^2,5\)

**Randomized controlled trials**

The report by Etman et al.\(^1\) assessed tooth and ceramic wear associated with three types of crowns. One practitioner inserted a total of 90 crowns in 48 patients (35% male, between 20 and 60 years of age) attending a dental hospital. Patients were randomized into three groups and had metal-ceramic, ceramic (Procera AllCeram), or experimental hot-pressed ceramic crowns (manufactured by Ivoclar Vivadent) placed on a posterior tooth following routine treatment procedures. Dental impressions were made at baseline and at six month intervals. Wear was measured by digitizing the impressions of the crown and the opposed tooth. A computerized 3-dimensional modeling system was used to quantify wear on contact surfaces. All three crown types showed steady increase in the loss of crown material at the contact areas from baseline to 24 months (\(p<0.05\)). The mean loss of crown material at 6, 12, 18, and 24 months was statistically significantly different between groups. The mean loss of crown material at 24 months was 321.6 \(\mu\)m (SD 12.8) for the Procera AllCeram, 214.8 \(\mu\)m (5.0) for the experimental ceramic, and 176.0 \(\mu\)m (3.9) for the metal-ceramic crown (\(p\) value not reported). Wear on the opposing tooth was the least for meta-ceramic crowns and the most for the Procera AllCeram crown. There was a statistically significant difference in tooth wear between the three groups (\(p<0.05\)). Tooth wear at 24 months was 261.6 \(\mu\)m (SD 12.9) for the Procera AllCeram crown, 214.9 \(\mu\)m (6.0) for the experimental crown, and 156.4 \(\mu\)m (14.3) for the metal-ceramic crown. The authors concluded that the experimental ceramic crown was superior to Procera AllCeram in terms of crown and enamel wear. The authors also concluded that wear due to the experimental ceramic crown was comparable to meta-ceramic crowns, although the statistical analysis to support this statement was not reported.\(^1\)

**Observational studies**

Dental crowns were evaluated in a retrospective cohort study using administrative data from the UK.\(^3\) The data were drawn from a database of payment claims from patients who received dental treatments from the General Dental Services of England and Wales between January 1991 and March 2002. A random sampling method was used to find patients who were 18 years or older and had a crown restoration. The life of the crown was estimated from the last payment claim in the initial placement of the crown to the next intervention on that tooth that was not related to maintenance. Kaplan-Meier analyses were conducted to assess the overall survival of
crowns, and survival according to crown type, characteristics of the patient, dentist, date of placement, and the location of the surgery.\textsuperscript{3}

The study identified 21,809 patients who had received at least one crown, 45\% of whom were males.\textsuperscript{3} Crowns were most frequently placed in patients aged 30 years to 39 years, followed by patients aged 40 years to 49 years. Eighty percent of the crowns were metal-ceramic, 16\% were metal, and 3\% were porcelain jacket crowns. Survival to next intervention was longest for all metal crowns followed by metal-ceramic and then porcelain crowns (Table 1). The differences between groups was statistically significant (p<0.0001).\textsuperscript{3} Several factors were associated with crown survival including tooth position (p<0.0001); teeth with root fillings (p<0.0001); dentist’s age, gender (p value not reported) and training (p=0.03); and patient factors such as gender (p=0.0006), age (p<0.0001), and patient’s frequency of dental treatment (p<0.0001). The authors concluded that metal crowns have the longest survival and porcelain crowns the shortest. Several factors related to the crown, patient, and dentist influence the outcome of the crown.

Table 1. Percentage survival to next intervention, by crown type\textsuperscript{3}

<table>
<thead>
<tr>
<th>Crown type</th>
<th>1 year survival</th>
<th>5 year survival</th>
<th>10 year survival</th>
<th>Number of crowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>All metal</td>
<td>94</td>
<td>80</td>
<td>68</td>
<td>7,817</td>
</tr>
<tr>
<td>Metal-ceramic</td>
<td>93</td>
<td>76</td>
<td>62</td>
<td>38,166</td>
</tr>
<tr>
<td>Porcelain</td>
<td>92</td>
<td>68</td>
<td>48</td>
<td>1,434</td>
</tr>
</tbody>
</table>

A retrospective case control study conducted in Australia assessed different crown types from a sample of patients drawn from three private dental practices.\textsuperscript{4} The sample of 100 patients (345 crowns) was drawn using a non-random method. All data were collected from patients’ treatment records. All restorations were placed before 1985 and had a follow up of at least 10 years. Crowns that were removed for reasons unrelated to the restoration (for example damage to the crown caused by endodontic treatment or removal of the tooth for periodontal reasons) were censored and not counted as a crown failure. Patient characteristics were similar in the three dental practices. The mean age of the patients at the time the crown was placed was 40.4 years (SD 12.0). Nine dentists placed the crowns, however, all 18 porcelain crowns were placed by one dentist. Metal-ceramic crowns had a higher percentage survival at 10 years and 15 years compared to porcelain crowns (statistical significance not reported) (Table 2).\textsuperscript{4}

Table 2. Percentage survival of dental crown, by crown type\textsuperscript{4}

<table>
<thead>
<tr>
<th>Crown type</th>
<th>5 year survival (SE)</th>
<th>10 year survival (SE)</th>
<th>15 year survival (SE)</th>
<th>Number of crowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full gold</td>
<td>95.4 (2.2)</td>
<td>92.8 (2.9)</td>
<td>86.0 (4.6)</td>
<td>93</td>
</tr>
<tr>
<td>Metal-ceramic</td>
<td>93.6 (1.8)</td>
<td>88.2 (2.4)</td>
<td>76.9 (4.3)</td>
<td>212</td>
</tr>
<tr>
<td>Porcelain</td>
<td>94.1 (5.7)</td>
<td>66.6 (14.0)</td>
<td>66.6 (14.0)</td>
<td>18</td>
</tr>
<tr>
<td>Cast onlay</td>
<td>72.7 (9.5)</td>
<td>40.8 (15.1)</td>
<td>Nil</td>
<td>22</td>
</tr>
</tbody>
</table>

SE=standard error

Limitations

In observational studies, the selection of crown type is not random. The decision to use a specific type of crown may be based on patient preference, cost, criteria set by the funding agency, or other factors which may have an impact on the performance of the crown. One
observational study\textsuperscript{3} controlled for known confounders in their statistical analysis and one study did not.\textsuperscript{4} The number of porcelain crowns was small and represented 3\%\textsuperscript{3} to 5\%\textsuperscript{4} of total crowns evaluated. In the observational studies it was unclear if the statistical analyses took into consideration clusters (some patients had more than one crown inserted). The outcome of one crown is predictive of others in the same patient.

In the study by Kelly and Smale\textsuperscript{s},\textsuperscript{4} the total number of crowns evaluated was small. Patients were selected from three dental practices which may limit generalizability. They used a non-random method to select patient records for inclusion in the study which may have introduced bias. The statistical methods used were not described.

Neither observational study provided details on the specific commercial crown products used, therefore it is not known if the products studied are the same as those currently in use in Canada.\textsuperscript{3,4}

The report by Kelly and Smale\textsuperscript{s} also included a cost-effectiveness analysis. Although they evaluated metal-ceramic and porcelain crowns, the reference group for the analysis was class 1 amalgam restoration. The methods used were not clearly reported and there was insufficient information provided to allow calculation of the cost-effectiveness of porcelain crowns compared to metal-ceramic crowns.

The randomized trial by Etman et al.\textsuperscript{1} did not clearly report methods used (e.g., randomization, blinding, follow up, allocation concealment), the number of patients per crown type, or statistical analysis of the results. The only outcome assessed was medium term wear. Wear was assessed using an impression of the teeth. The amount of error introduced in the process of creating the impression was not quantified. It is not clear if the statistical analysis took into consideration clusters.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING:

We identified no systematic reviews, health technology assessments, meta-analyses, economic analysis, or guidelines that met the inclusion criteria for this HTIS inquiry.

The survival of metal-ceramic crowns was higher than porcelain crowns based on two retrospective observational studies. Several factors related to the crown, patient, and dentist influence the survival of the crown. Porcelain crowns showed a higher wear rate than metal-ceramic crowns over a two year period based on a randomized controlled trial.

No specific conclusions can be drawn regarding prognosis or complications associated with different crown types although some of this information may have been captured in the UK observational study which looked at the survival time of the crown to the next intervention. No conclusions regarding the relative costs of different types of crowns can be made. The limited information identified as well as other factors such as patient preference should be considered when deciding on the type of crown.

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APPENDIX: Excluded studies

Two systematic reviews were identified that compared metal-ceramic to porcelain single crowns or implant supported crowns. A review of the studies and methods used in the meta-analysis revealed that the results were based on an indirect comparison between the two crown types. The individual studies included in the review had no comparator group. That is, each study only analyzed the survival and complication rate of one type of crown. Studies on metal-ceramic crowns were pooled and compared to pooled results of other studies assessing porcelain crowns. As noted above, the performance of a crown is related to several factors (such as tooth position, dentist, and patient characteristics) other than the crown material. With an indirect comparison it is not possible to control for any of these other factors therefore no conclusions can be drawn from these systematic reviews.