TITLE: Metal-Ceramic versus All-Ceramic Dental Crowns: A Review of the Clinical and Cost-Effectiveness

DATE: 15 January 2013

CONTEXT AND POLICY ISSUES

Porcelain-fused-to-metal (PFM) crowns have been considered the gold standard for the repair of damaged teeth. PFM crowns have good mechanical properties, satisfactory esthetic results, and an acceptable biological quality needed for periodontal health. However, PFM crowns have some limitations that may limit their use. The fabrication of PFM is a highly technique-sensitive procedure that consists of investing wax patterns and casting precious metal alloys. Furthermore, the esthetic of PFM crowns is limited by the metal framework and the layer of opaque porcelain needed for masking the underlying metal grayish shade. Recently the cost of precious metals has risen markedly making PFM relatively unattractive from an economic standpoint.

Ceramic crowns have been tried in the last four decades to replace PFM crowns and overcome their esthetic limitations. However, the use of all-ceramic crowns has been challenged in practice by the uncertainty of their physical proprieties and their resistance to fracture and chipping.

Policy makers require information on the relative benefits and costs associated with different types of crown materials in order to support reimbursement decisions. The objective of this review is to evaluate the clinical and cost-effectiveness of dental PFM and all-ceramic crowns.

RESEARCH QUESTIONS

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

2. What is the cost-effectiveness of all-ceramic dental crowns compared with metal-ceramic dental crowns?
KEY FINDINGS

The short term (< 5 years) survival of all-ceramic crowns is comparable to porcelain fused to metal crowns. No conclusions can be made on the comparative long-term survival or cost-effectiveness because of study limitations.

METHODS

Literature Search Strategy

A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2012, Issue 12), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI (Health Devices Gold), Canadian and major international health technology agencies, as well as a focused Internet search. Methodological filters were applied to a broad search of any type of dental crown to limit retrieval to health technology assessments, systematic reviews, meta-analyses, randomized controlled trials and economic studies. No filters were applied to a narrower search of articles comparing all-ceramic to metal-ceramic dental crowns. Where possible, retrieval was limited to the human population. The clinical search was also limited to English language documents published between January 1, 2007 and December 6, 2012. The search for economic studies was limited to documents published between January 1, 2002 and December 6, 2012.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed for relevance. Full texts of any relevant titles/abstracts were retrieved, and assessed for inclusion. The final article selection was based on the inclusion criteria presented in Table 1.

Table 1: Selection Criteria

<table>
<thead>
<tr>
<th>Population</th>
<th>Adults receiving single crowns on natural teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>Porcelain fused to metal (PFM) crowns</td>
</tr>
<tr>
<td>Comparator</td>
<td>All-ceramic crowns</td>
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<tr>
<td></td>
<td>- prepared in the lab or dental cabinet including (but not limited to)</td>
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<tr>
<td></td>
<td>- alumina ceramic (Procera, Nobel Biocare, In-Ceram, Vident);</td>
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<td></td>
<td>- zirconia ceramics (Lava, Castle Total Zirconia - CTZ);</td>
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<td></td>
<td>- hot-pressed leucite reinforced ceramics (Empress, Cerpress);</td>
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<tr>
<td></td>
<td>- zirconium, leucite-reinforced ceramic, and titanium (Everest - KaVo);</td>
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<tr>
<td></td>
<td>- any other type of Computer-Aided Design and Computer-Aided Manufacturing in dentistry (CAD/CAM) or Chair-side Economical Restoration of Esthetic Ceramic (CEREC) crowns.</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Longevity, prognosis, complications, cost effectiveness</td>
</tr>
<tr>
<td>Study Designs</td>
<td>Health technology assessments, systematic reviews, meta-analyses, randomized-controlled trials, observational studies and economic evaluations</td>
</tr>
</tbody>
</table>
Exclusion Criteria

Studies were excluded if they did not meet the selection criteria. Duplicate reports of the same outcomes from the same trials were also excluded. Additionally, effectiveness studies were excluded if they did not directly compare metal-fused to metal crowns with all-ceramic crowns; systematic reviews that indirectly compared the two crown systems were included in the review. Studies of crowns on implant abutments were excluded.

Critical Appraisal of Individual Studies

Critical appraisal of the included studies was based on study design. The methodological quality of the included systematic review was evaluated using the “assessment of multiple systematic reviews” (AMSTAR). AMSTAR is an 11-item checklist that has been developed to ensure reliability and construct validity of systematic reviews. The methodological quality of the included randomized controlled trials was evaluated using the SIGN50 checklist for the controlled studies. The non-randomized controlled trials included in this review were evaluated using the SIGN50 checklist for the cohort studies. The methodological quality of the included cost-effectiveness studies were assessed using the guidelines for appraisal of economic studies by Drummond et al.

For the included studies a numeric score was not calculated. Instead, the strengths and limitations of the study were described narratively.

SUMMARY OF EVIDENCE

Quantity of Research Available

A total of 746 potential citations were identified by the search in bibliographic database, with 738 citations being excluded during the title and abstract screening based on irrelevance to the questions of interest. The full text documents of the remaining eight articles were retrieved. Three additional articles were identified by the grey literature search. Of the 11 articles, five did not meet the inclusion criteria and were excluded, leaving six articles that reported from six unique trials to be included in this review. A PRISMA diagram demonstrating the study selection process is presented in APPENDIX 1.

Summary of Study Characteristics

Six trials that addressed at least one of the review questions were included in this review, including one systematic review, two randomized-controlled trials, two non-randomized trials, and one cost-effectiveness study. Details regarding primary studies characteristics are tabulated in APPENDIX 2.

Pjetursson et al. conducted a systematic review of cohort studies of evaluating all-ceramic crowns or PFM crown; none of the include studies compared both types of crowns. All-ceramic and PFM crowns were compared by an indirect comparison meta-analysis. A total of 34 studies published between 1991 and 2006 were included in the review. The included studies evaluated more than 6000 crowns which were followed-up for five years.

The randomized-controlled trial by Esquivel-Upshaw et al. allocated 36 crowns (31 patients) to PFM, non-veneered all-ceramic, or veneered all-ceramic crowns. Patients were followed-up
for 3 years. The three crown types were compared in terms of their clinical performance in terms of periodontal and dental tissue integrity, crown structural and esthetic integrity, and the relationship of the crown relative to their proximal teeth. Etman et al. conducted another randomized-controlled trial in which 90 crowns (48 patients) were randomly allocated to PFM crowns, modified lithium all-ceramic crowns, or alumina-coping all-ceramic crowns. Patients were followed-up for three years, and restorations were evaluated in terms of the United States Public Health Services criteria for dental restorations.

Zirconia crowns were compared with PFM crowns in a non-randomized trial by Rinke et al. The trial was conducted in a private clinic, and included 49 patients who were treated with 105 crowns by one dentist. Patients were followed-up for three years and were evaluated by crown survival, success and chipping rates. Burke et al. evaluated the records of 21,809 patients who were treated with 47,417 all-ceramic (porcelain jacket), PFM or all-metal crowns (gold crowns). The mean retrospective follow-up was 10 years, and the three crown types were compared in terms of their survival rates.

Kelly et al. evaluated and compared the cost-effectiveness of alternative methods for restoring large tooth substance loss in adults. The PFM crowns and all-ceramic (porcelain jacket) crowns were included in the compared methods; Class I amalgam restorations were used as a reference for the comparison between the other methods. The analysis was based on patients’ record data with all restorations performed before 1985 and followed-up for at least 10 years.

Summary of Critical Appraisal

The strength and limitations of included studies are summarized in APPENDIX 3

Restoration survival was used as an outcome in four studies, however, these studies were limited in terms of the used survival definition. Pjetursson et al. and Rinke et al. defined survival as the crown remaining in situ; this definition did not consider the possible complications and chipping fractures that could occur. The impact of such definition is that the produced survival estimates have tendency to be overestimated, because it ignores the possible clinical complications of these restorations. Rinke et al. and Kelly et al. did not report any definition for survival.

The provision of PFM or all-ceramic crowns was not randomized in four studies; the decision to use a specific crown type 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 (e.g., the remaining tooth structure).

In three studies, the follow-up duration was relatively short compared to the expected survival of dental crowns. Survival rates were estimated at three years of the crown’s life in the three studies; these evaluations are overestimated and may not be representative for the survival at longer duration of follow-up. On the other hand, two studies included restorations performed since 1990, and one study evaluated the survival of crowns fabricated before 1985, dental materials used in these crowns fabrication have been changed considerably since the installation of these crowns. This may affect the generalizability of the study results.

Summary of Findings

A summary of study findings and authors’ conclusions are provided in APPENDIX 4.
Dental Crown Survival

Short to medium term (< 5 years) survival analysis showed that posterior all-ceramic crowns fabricated from alumina, reinforced glass-ceramic, zirconia, or lithium disilicate had comparable survival rates to posterior PFM crowns.\textsuperscript{10,12,13} InCeram and glass-ceramic all-ceramic crowns had statistically significant lower survival rate that PFM crowns when used for posterior teeth. When used for anterior teeth all the ceramic crown systems were comparable to the PFM crowns in terms of survival rates at short term. The long term evaluation of the aforementioned all-ceramic materials was not evaluated in the included studies. Two studies reported the long terms survival (≥10 years) for all-ceramic (porcelain jacket) crowns only,\textsuperscript{14,15} both studies showed that at porcelain jacket crowns had statistically significantly lower survival rate than PFM crowns.

Clinical Performance

The clinical performance was evaluated in two studies.\textsuperscript{11,13} Although the definition of clinical performance was not the same in both studies, the definitions generally evaluated esthetic, anatomic and structural integrity, and the occlusal harmony of the dental crowns. In both studies, it was shown that all-ceramic crowns did not differ from PFM crowns in the clinical performance criteria except for the color match, which favored all-ceramic crowns,\textsuperscript{13} and occlusal wear that favored PFM crowns.\textsuperscript{11}

Cost-effectiveness of porcelain fused to metal and all-ceramic crowns

Kelly et al.\textsuperscript{15} reported that the cost-effectiveness values at 5 and 10 years of all-ceramic (porcelain jacket) crowns relative to Class I amalgam were higher than those of PFM crowns relative to Class I amalgam. However, this relationship was reversed at the 15 year evaluation, and PFM crowns were more cost-effective than porcelain jacket crowns. Interpretation of these finding should be in light of the fact that there were a limited number of porcelain jacket crowns (18) compared to PFM crowns (212).

Limitations

The current review might be limited by the fact the newer ceramic materials available in practice were evaluated for a limited period of time. Longer follow-up evaluation is available for porcelain jacket all-ceramic crowns only; the materials used in the fabrication of these crowns have been improved in the last two decades, and the results obtained from the included studies might not be representative to the currently used materials.

The cost-effectiveness study was based on Australian prices of dental restorations in 1992; the current review did not attempt the adjustment for currency change of inflation rates since 1992. Therefore, these prices might not be representative to the Canada prices of dental restorations in 2013.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

This report compared the survival rates of porcelain fused to metal crowns to all-ceramic crowns. The clinical performance and the cost-effectiveness of the two types of crowns were also reviewed. A total of five studies and a systematic review were retrieved.
With respect to the survival of dental crowns, the short term (< 5 years) data showed that all-ceramic crowns when used for anterior teeth had survival rates comparable to PFM crowns. When the survival rates of posterior crowns were compared, the difference between PFM and all-ceramic crowns was dependent of ceramic material used. All-ceramic posterior crowns fabricated from alumina, zirconia, or reinforced glass-ceramic had comparable survival rate to PFM. InCeram and glass-ceramic crowns had statistically significant lower survival rate than PFM crowns when used for posterior teeth. Long terms (>10 years) survival was available for porcelain jacket crowns, and it was found statistically significantly lower than that of PFM crowns.

The cost-effectiveness analysis showed that all-ceramic (porcelain jacket) crowns were more cost-effective than PFM crowns until 10 years of the restoration life; after this time, PFM crowns become more cost-effective. However, these findings might not be generalizable to the currently used all-ceramic crowns because the study was based on restorations fabricated before 1985.

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REFERENCES


APPENDIX 1: Selection of Included Studies

746 citations identified from electronic literature search and screened

738 citations excluded

8 potentially relevant articles retrieved for scrutiny (full text, if available)

3 potentially relevant reports retrieved from other sources (grey literature, hand search)

11 potentially relevant reports

5 reports excluded:
- Not appropriate comparator (2)
- Duplicate publication (1)
- Review articles (not systematic)(2)

6 reports included in review
APPENDIX 2. Characteristics of the Included Studies

Characteristics of the Included Systematic Review

<table>
<thead>
<tr>
<th>Review Objectives</th>
<th>Types of Studies and Types of Participants</th>
<th>Interventions and Comparators</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pjetursson et al. 2007(^\text{10}) – Switzerland</td>
<td>● <strong>Type of Studies</strong>&lt;br&gt;  o 34 studies (published from 1991 to 2006)&lt;br&gt; ▪ 28 cohort studies on all-ceramic crowns (18 prospective, 10 retrospective)&lt;br&gt; ▪ 6 cohort studies on porcelain fused to metal crowns (3 prospective, 3 retrospective)&lt;br&gt; ▪ No RCT comparing the two systems was found</td>
<td>● <strong>Intervention:</strong>&lt;br&gt;  o All-ceramic crowns (N=28)&lt;br&gt; ▪ Glass-infiltrated alumina (InCeram), n= 11 studies/ 1915 crowns&lt;br&gt; ▪ Glass ceramic (Jacket crowns, Ceresrore, HiCeram, Feldspat, and Decor), n=8/ 1679 crowns&lt;br&gt; ▪ Reinforced glass-ceramic crowns (Empress), n=8/ 1683 crowns&lt;br&gt; ▪ Alumina crowns (Procera), n=5/ 729 crowns&lt;br&gt;</td>
<td>● <strong>Primary outcomes:</strong>&lt;br&gt;  o Survival rate of the dental crowns&lt;br&gt; ▪ Defined as the crown remaining in situ with or without modification during the entire observation period.</td>
</tr>
<tr>
<td></td>
<td>● <strong>Types of Participants</strong>&lt;br&gt;  o Age range from 17 to 82 years</td>
<td>● Comparator:&lt;br&gt;  o Porcelain fused to metal (N=6)&lt;br&gt;  o 1765 crowns follow-up for 9.2 years</td>
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</tr>
</tbody>
</table>

To evaluate the 5-year survival rates of all-ceramic and metal-ceramic singles crowns.<br> Systematic review and Indirect comparison meta-analysis
### Characteristics of the Included Controlled Trials

<table>
<thead>
<tr>
<th>Study Objectives and Design</th>
<th>Inclusion Criteria, Sample Size, and Patient Characteristics</th>
<th>Intervention, Comparator, and Study Conduct</th>
<th>Clinical Outcomes</th>
</tr>
</thead>
</table>
| To evaluate the clinical performance of PFM crowns, core ceramic crowns, and core ceramic/veneer ceramic crowns. Single blind RCT | **Inclusion Criteria:** patients with  
- Indication for extracoronal single tooth restorations  
- Intact or minimally restored opposing teeth  
- No active caries, periodontal disease, or periodontal pockets > 4 mm  
- No TMD, or para-functional habits  
- Crown required for 2nd premolar, 1st or 2nd molars  
- Crown/ root ratio ≥ 1:1  
**Sample size:**  
- Maximum of two teeth were allowed per patient  
- 36 crowns in 31 patients  
**Patients characteristics:**  
- Not reported | **Intervention:**  
- PFM crown (N=12)  
  - Metal: Palladium-based alloy (Argedent 62)  
  - Glass-ceramic veneer (IPS d.SIGN veneer)  
**Comparators:**  
- All-ceramic crown (N=12)  
  - non-veneered (glazed) lithium disilicate (LDC) (IPS e.max Press core and e.max Ceram Glaze)  
  - All-ceramic crown (N=12)  
  - veneered lithium disilicate glass-ceramic crown (LDC/V) with glass-ceramic veneer (IPS Empress 2 core and IPS Eris)  
**Study Conduct:**  
- patients recruited from an Academic healthcare facility  
- 3-year follow-up  
  - Yearly recall  
  - One patient withdrawn from the study | Clinical performance as measured by the following criteria:  
- Tissue health,  
- Marginal integrity,  
- Secondary caries,  
- Proximal contact,  
- Anatomic contour,  
- Occlusion,  
- Surface texture,  
- Cracks/chips (fractures),  
- Color match,  
- Tooth sensitivity, and  
- Wear (of crowns and opposing enamel)  
Rankings of each criterion were made on a scale from 1 to 4:  
- 4 as excellent,  
- 3 as good,  
- 2 as unacceptable (and needing repair or replacement in the near future), and  
- 1 as unacceptable condition (but needing immediate replacement)  
Method of the overall assessment was not described |
### Characteristics of the Included Controlled Trials

<table>
<thead>
<tr>
<th>Study Objectives and Design</th>
<th>Inclusion Criteria, Sample Size, and Patient Characteristics</th>
<th>Intervention, Comparator, and Study Conduct</th>
<th>Clinical Outcomes</th>
</tr>
</thead>
</table>
| Rinke et al. 2011<sup>12</sup> – Germany (Non-randomized trial) | **Inclusion Criteria:**
  - Consecutive patients in a private clinic
  - Vital teeth or sufficiently endodontically treated teeth
  - The study excluded patients with bruxism
  **Sample size:**
  - 49 patients
  - 105 crowns
  **Patients characteristics:**
  - Mean age was 49.6 years | **Intervention:**
  - Zirconia crowns (N= 55 crowns)
  - Cercon system – prepared by the CAD/CAM system
  **Comparators:**
  - PFM crown (N= 50 crowns)
  - Metal: high-noble alloy
  - Porcelain: low-fusing porcelain
  **Study Conduct:**
  - The type of restoration was based on patients’ preference
  - Mean follow-up of 36.5 months | - Time-dependent survival (defined as the reconstruction remaining in situ at the follow-up examination visit without presenting an absolute failure)
  - Success rate (defined as a reconstruction that remained unchanged and did not require any intervention to maintain function during the entire observational period)
  - Chipping rate |
| Etman et al. 2010<sup>13</sup> – UK (Randomized controlled trial) | **Inclusion Criteria:**
  - Patients with indication for extracoronal single tooth restorations
  - Intact or minimally restored opposing teeth
  - No history of parafunctional activities
  **Sample size:**
  - Up to three crowns were allowed for each patient
  - 90 crowns in 48 patients
  - 6 1<sup>st</sup> premolars
  - 18 2<sup>nd</sup> premolars
  - 52 1<sup>st</sup> molars
  - 14 2<sup>nd</sup> molars
  **Patients characteristics:**
  - Not reported | **Intervention:**
  - All-ceramic crown
  - Modified lithium disilicate ceramic (IPS e.max Press)
  **Comparators:**
  - PFM crown
  - Metal: Palladium-based noble alloy (Simidur S2)
  - Porcelain: Feldspathic porcelain (IPS Classic veneer)
  - All-ceramic crown
  - Alumina-coping-based ceramic (Procera AllCer)
  **Study Conduct:**
  - Patients recruited in a hospital setting
  - 3-year follow-up
  - Every 6-month recall | Clinical performance as measured by the modified USPHS criteria for evaluation of indirect restorations. Rankings of each category were made on a 4-point scale:
  - Alpha = excellent (restorations without changes/clinically ideal)
  - Bravo = Acceptable results (restorations with changes that are clinically acceptable/don’t require replacement)
  - Charlie = unacceptable, restorations with changes that require replacement
  - Delta = unacceptable, immediate replacement necessary |

**USPHS** = United States Public Health Services criteria for dental restorations
### Characteristics of the Included Controlled Trials

<table>
<thead>
<tr>
<th>Study Objectives and Design</th>
<th>Inclusion Criteria, Sample Size, and Patient Characteristics</th>
<th>Intervention, Comparator, and Study Conduct</th>
<th>Clinical Outcomes</th>
</tr>
</thead>
</table>
| **Burke et al. 2009**¹⁴ – UK (Non-randomized trial) | Consider the factors associated with the need for re-intervention on a crown, and the times to re-intervention. Retrospective non-randomized study | **Inclusion Criteria**: patients with  
* a data set was created by random selection from health insurance dataset,  
* consisted of crowns which have been placed, with their dates of placement and their dates, if any, of re-intervention  
* insurance claims between 1990 to 2002  
**Sample size**:  
* 21,809 patients  
  * A total of 47,417 crowns  
  * Mean follow-up of 10 years  
**Patients characteristics**:  
45% of patients had 30 to 39 years | **Intervention**:  
* All-porcelain crowns (N=1,434)  
**Comparators**:  
* Metal-ceramic crowns (N=38,166)  
* All metal crowns (N=7,817)  
Survival rate of dental crowns. Survival rate was not defined |
### Cost-effectiveness of Porcelain Fused to Metal and All-Ceramic Crowns

<table>
<thead>
<tr>
<th>Study Objectives &amp; Design</th>
<th>Data collection/ Assumptions</th>
<th>Interventions</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kelly et al, 2004</strong>&lt;sup&gt;15&lt;/sup&gt; – Australia</td>
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</table>
| Determine the relative cost-effectiveness of alternative methods for restoring large tooth substance loss in adults. | The study included was based on retrospective survival data of molar restorations placed in three private clinics with the participation of none dentists. All restorations were placebo before 1985 and followed-up for at least 10 years. Data were collected patients records. Survival analysis excluded (censored) crowns removed due to endodontic treatment or periodontal diseases. Restoration costs were discounted to the mean costs in South Australian metropolitan in 1992. | Posterior dental restorations:  
- Full gold crowns  
- Ceramo-metal crowns  
- Cast onlay  
- Porcelain jacket crowns  
- Class I amalgam  
- Class II amalgam  
- Class IV resin composite | Cost-effectiveness of the dental restorative treatment defined as the difference in the discounted costs incurred between treatment A and treatment B divided by the difference in their effectiveness (restoration survival). Lower values mean higher benefits derived. Effectiveness was based on restoration survival; however, survival rate was not defined in the report. |
### APPENDIX 3. Critical Appraisal of the Included Studies

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Limitations</th>
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</thead>
<tbody>
<tr>
<td><strong>Pjetursson et al. 2007</strong> – Switzerland (Systematic review)</td>
<td></td>
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</tbody>
</table>
| • The review was conducted according a priori protocol.  
  • Two reviewers participate in the literature selection and data extraction. | • Crown survival was defined as the crown remaining in situ with or without modification during the entire observation period. This definition did not consider the possible complication and chipping fractures that could occur.  
  • The quality of the included studies was not evaluated. |
| **Esquivel-Upshaw et al. 2012** – USA (Randomized-controlled trial) |  |
| • Allocation to porcelain fused to metal or all-ceramic crowns was randomized. Randomization was computer generated. | • The study did not conduct power calculation to estimate the sample size.  
  • Due to the type of intervention, blinding was not possible  
  • The duration of follow-up is relatively short. The expected survival for PFM is around 10 years, while the follow-up duration was 3 years. |
| **Rinke et al. 2011** – Germany (Prospective non-randomized study) |  |
| • The study was conducted according a priori protocol | • The study was based on one private practice, and dental crown preparation is affected by the skills and experience of the dentist. The results obtained in this study might not be generalizable to other dentists.  
  • The allocation to the crown type was not randomized, and it was based on patients’ preference. However, this is what is likely to encounter in practice.  
  • The study did not conduct power calculation to estimate the sample size.  
  • Due to the type of intervention, blinding was not possible  
  • The duration of follow-up is relatively short. The expected survival for PFM is around 10 years.  
  • The study excluded patients with bruxism. Generalizability of results to this type of patients is limited. |
| **Etman et al. 2010** – UK (Randomized-controlled trial) |  |
| • Sample size was based on power calculation; however, the article did not report the outcome on which this calculation was based.  
  • Allocation to porcelain fused to metal or all-ceramic crowns was randomized. However, the randomization method was not described. | • One operator conducted all treatments, skills and experience of this dentist might not be generalizable to other dentists.  
  • Due to the type of intervention, blinding was not possible  
  • The duration of follow-up is relatively short. The expected survival for PFM is around 10 years. |
<table>
<thead>
<tr>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| **Burke et al. 2009**<sup>14</sup> – UK (Retrospective non-randomized study) | • The selection of restoration was not randomized, and the survival of crowns might be affected by the cause behind selecting the type of restoration.  
• The study was based on restorations placed between 1990 and 2002, dental materials used in crown fabrication have been changed considerably since the beginning data collection. This may affect the generalizability of the study results. |
| • The study included a considerable sample size with a follow-up enough to evaluate the survival of dental crowns. |                                                                                                 |
| **Kelly et al, 2004**<sup>15</sup> – Australia (Cost-effectiveness Study)  | • The selection of restoration was not randomized, and the survival of crowns might be affected by the cause behind selecting the type of restoration.  
• The study was based on restorations placed before 1985, dental materials used in crown fabrication have been changed considerably since then. This may affect the generalizability of the study results. |
| • The cost-effectiveness analyses were based on real data obtained from three different dental practices.  
• Prices were adjusted (discounted) from the time of teeth restoration to the time when the study was conducted |                                                                                                 |
## APPENDIX 4. Main Study Findings and Authors’ Conclusions

<table>
<thead>
<tr>
<th>Study Findings</th>
<th>Authors’ Conclusions</th>
</tr>
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<tbody>
<tr>
<td><strong>Pjetursson et al. 2007</strong>&lt;sup&gt;10&lt;/sup&gt; – Switzerland</td>
<td>• When used for anterior teeth, all-ceramic crowns showed 5-year survival rates comparable to PFM crowns</td>
</tr>
<tr>
<td><strong>Survival Estimates of the Compared Crown Systems</strong></td>
<td>• For posterior teeth, the 5-year survival of alumina crowns and reinforced glass-ceramic crowns were similar to PFM crowns</td>
</tr>
<tr>
<td>N  PFM  Alumina  Glass-ceramic  Reinforced glass-ceramic  InCeram</td>
<td>• InCeram and glass-ceramic crowns had lower 5-year survival than PFM crowns.</td>
</tr>
<tr>
<td>Follow-up 9.2 years 4.5 years 6.9 years 4.2 years 3.7 years</td>
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</tr>
<tr>
<td>Failure rate&lt;sup&gt;a&lt;/sup&gt; 0.89 0.74 2.67 0.94 1.13</td>
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</tr>
<tr>
<td>5-year survival rate 95.6% 96.4% 87.5%&lt;sup&gt;b&lt;/sup&gt; 95.4% 94.5%</td>
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<tr>
<td>Relative failure 1&lt;sup&gt;(reference)&lt;/sup&gt; 0.74 2.3&lt;sup&gt;b&lt;/sup&gt; 0.93 1.27</td>
<td></td>
</tr>
<tr>
<td>Chipping rate&lt;sup&gt;a&lt;/sup&gt; 1.17 0.79</td>
<td></td>
</tr>
<tr>
<td><strong>Anterior teeth crowns</strong></td>
<td></td>
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<tr>
<td>N  NR  133 590 792 533</td>
<td></td>
</tr>
<tr>
<td>Failure rate&lt;sup&gt;a&lt;/sup&gt; NR 0.67 1.8 0.85 0.68</td>
<td></td>
</tr>
<tr>
<td><strong>Posterior teeth crowns</strong></td>
<td></td>
</tr>
<tr>
<td>N  NR  296 1105 698 832</td>
<td></td>
</tr>
<tr>
<td>Failure rate&lt;sup&gt;a&lt;/sup&gt; NR 1.05 3.39&lt;sup&gt;c&lt;/sup&gt; 1.29 2.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;a&lt;/sup&gt; failure rate per 100 crown years</td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;b&lt;/sup&gt; statistically significantly lower than PFM</td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;c&lt;/sup&gt; statistical difference between anterior and posterior teeth crowns</td>
<td></td>
</tr>
</tbody>
</table>

### Esquivel-Upshaw et al. 2012<sup>11</sup> – USA

<table>
<thead>
<tr>
<th>Proportion of good/excellent ratings for the three ceramics</th>
<th>PFM (N=12)</th>
<th>LDC (N=12)</th>
<th>LDC/V (N=12)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue health</td>
<td>91</td>
<td>100</td>
<td>100</td>
<td>0.99</td>
</tr>
<tr>
<td>Marginal integrity</td>
<td>91</td>
<td>100</td>
<td>100</td>
<td>0.99</td>
</tr>
<tr>
<td>Secondary caries</td>
<td>82</td>
<td>100</td>
<td>100</td>
<td>0.31</td>
</tr>
<tr>
<td>Proximal contact</td>
<td>91</td>
<td>91</td>
<td>100</td>
<td>0.99</td>
</tr>
<tr>
<td>Anatomic contour</td>
<td>91</td>
<td>91</td>
<td>100</td>
<td>0.99</td>
</tr>
<tr>
<td>Occlusion</td>
<td>91</td>
<td>100</td>
<td>100</td>
<td>0.99</td>
</tr>
<tr>
<td>Surface texture</td>
<td>91</td>
<td>18</td>
<td>27</td>
<td>0.0013</td>
</tr>
<tr>
<td>Crack/chip/fracture</td>
<td>73</td>
<td>91</td>
<td>91</td>
<td>0.58</td>
</tr>
<tr>
<td>Color match</td>
<td>82</td>
<td>82</td>
<td>73</td>
<td>0.99</td>
</tr>
<tr>
<td>Tooth sensitivity</td>
<td>82</td>
<td>100</td>
<td>100</td>
<td>0.31</td>
</tr>
<tr>
<td>Wear of antagonist</td>
<td>90</td>
<td>100</td>
<td>82</td>
<td>0.76</td>
</tr>
<tr>
<td>Wear of crown</td>
<td>90</td>
<td>27</td>
<td>45</td>
<td>0.0078</td>
</tr>
</tbody>
</table>

MC= porcelain fused to metal crown; LDC= lithium-disilicate-based ceramic crown; LDC/v= veneered lithium-disilicate-based ceramic crown

“Gradual surface roughening was observed between years 2 and 3 for the veneered lithium-disilicate-based ceramics with no apparent volume wear loss. The glass-ceramic veneer for metal-ceramic crowns performed better clinically with regard to surface texture.”
### Study Findings

**Survival Estimates of Porcelain Fused to Metal and Zirconia Crowns**

<table>
<thead>
<tr>
<th></th>
<th>PFM crowns</th>
<th>Zirconia crowns</th>
<th>Difference between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>48</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Failed crowns, n</td>
<td>1 (due to secondary caries)</td>
<td>2 (chipping grade 3)</td>
<td></td>
</tr>
<tr>
<td>3-year success rate</td>
<td>90.9%</td>
<td>86.8%</td>
<td>(P=0.49)</td>
</tr>
<tr>
<td>3-year survival rate</td>
<td>97.6%</td>
<td>95.2%</td>
<td>(P=0.53)</td>
</tr>
<tr>
<td>Chipping (reparable)</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

**Etman et al. 2010\(^3\) – UK**

Three-year longevity:
- Alumina (Procera AllCeram) – 96.6%
- Lithium disilicate (IPS e.max Press) – 96.6%
- PFM – 100%

Proportion of alpha ratings for the three ceramics

<table>
<thead>
<tr>
<th></th>
<th>PFM (N=30)</th>
<th>IPS e.max Press (N=30)</th>
<th>Procera AllCeram (N=30)</th>
<th>Statistical testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity (irreparable defects)</td>
<td>0 (0)</td>
<td>1 (3.3)</td>
<td>1 (3.3)</td>
<td>NR</td>
</tr>
<tr>
<td>Reparable defect</td>
<td>1 (3.3)</td>
<td>0</td>
<td>1 (3.3)</td>
<td>NR</td>
</tr>
<tr>
<td>Color match</td>
<td>NR</td>
<td>24 (80)</td>
<td>26 (86.7)</td>
<td>SS(^a)</td>
</tr>
<tr>
<td>Optimal health</td>
<td>30 (100)</td>
<td>21 (70)</td>
<td>26 (86.7)</td>
<td>NR</td>
</tr>
<tr>
<td>Anatomic form</td>
<td>NR</td>
<td>30 (100)</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Marginal integrity</td>
<td>30 (100)</td>
<td>27 (90)</td>
<td>27 (90)</td>
<td>NR</td>
</tr>
<tr>
<td>Marginal discoloration</td>
<td>NR</td>
<td>2 (6.6)</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Post-treatment sensitivity</td>
<td>12 (40)</td>
<td>7 (23.3)</td>
<td>10 (33.3)</td>
<td>NR</td>
</tr>
<tr>
<td>Mean alpha (SD)</td>
<td>15.5 (1.2)</td>
<td>16.8 (1.1)</td>
<td>14.57 (0.9)</td>
<td>(p)-value &gt; 0.05</td>
</tr>
</tbody>
</table>

\(^a\) MC differed from the IPS and Procera crowns
MC= porcelain fused to metal crown;

**Burke et al. 2009\(^4\) – UK**

<table>
<thead>
<tr>
<th></th>
<th>PFM Crown</th>
<th>Porcelain Jacket Crown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of crowns</td>
<td>38,166</td>
<td>1,434</td>
</tr>
<tr>
<td>Percentage survival</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 year</td>
<td>93%</td>
<td>92%</td>
</tr>
<tr>
<td>5 years</td>
<td>76%</td>
<td>68%</td>
</tr>
<tr>
<td>10 years</td>
<td>62%</td>
<td>48(^a)</td>
</tr>
</tbody>
</table>

\(^a\) the difference between groups is statistically significant

### Authors’ Conclusions

Three-year survival analyses:
- Metal–ceramic and zirconia-based molar crowns did not differ statistically in crown survival
- Technical complication rates (veneer ceramic fractures) was similar for the zirconia and metal–ceramic molar crowns

"the IPS e.max Press crowns demonstrated clinical performance comparable to Procera AllCeram and metal ceramic crowns over a 3-year period of study"
## Study Findings

<table>
<thead>
<tr>
<th>Survival and cost-effectiveness estimates, by crown type</th>
<th>Authors’ Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kelly et al, 2004</strong> – Australia</td>
<td></td>
</tr>
</tbody>
</table>

### The anterior ceramo-metal crowns were more cost effective than porcelain jacket crowns over the longer term.

<table>
<thead>
<tr>
<th></th>
<th>PFM crown</th>
<th>Porcelain Jacket crown</th>
<th>Class I amalgam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of restorations</td>
<td>212</td>
<td>18</td>
<td>269</td>
</tr>
<tr>
<td>Percentage survival</td>
<td>5-year</td>
<td>93.3%</td>
<td>94.1%</td>
</tr>
<tr>
<td></td>
<td>10-year</td>
<td>88.2%</td>
<td>66.6%</td>
</tr>
<tr>
<td></td>
<td>15-year</td>
<td>76.9%</td>
<td>66.6%</td>
</tr>
<tr>
<td>Discounted costs (A$)</td>
<td>1992</td>
<td>695</td>
<td>606.4</td>
</tr>
<tr>
<td>Incremental cost</td>
<td>5-year</td>
<td>245.1</td>
<td>173.4</td>
</tr>
<tr>
<td>effectivenes ratio</td>
<td>10-year</td>
<td>160.3</td>
<td>-19.1(^a)</td>
</tr>
<tr>
<td>(relative to Class I</td>
<td>15-year</td>
<td>-49.6(^a)</td>
<td>-17.0(^a)</td>
</tr>
<tr>
<td>amalgam)(^b)</td>
<td></td>
<td></td>
<td>Reference</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reference</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reference</td>
</tr>
</tbody>
</table>

\(^{a}\) negative value denotes that the restoration survival was less than the Class I amalgam

\(^{b}\) lower values mean higher benefits