An Evaluation of Two Modern All-Ceramic Crowns and their comparison with Metal Ceramic Crowns in terms of the Translucency and Fracture Strength

Girish Nazirkar, Suresh Meshram

Abstract

Background: Metal ceramic restorations are highly popular and are used for most of the crown and bridge restorations made today. Aims: To evaluate the translucency and fracture strength of two all-ceramic and traditional metal ceramic crowns. Materials and Methods: Thirty crowns of similar size and shape were constructed to fit a standard brass die. Ten crowns were manufactured from each of the following groups of materials: Vita Inceram, Metal Ceramic and Conventional All Ceramic. Modified Warpeha Goodkind test in which the ceramic crowns were fractured in an attempt to simulate the prosthetic configuration of the components. Results: The metal ceramic crowns were significantly more resistant to fracture than the two all-ceramic crowns, but all ceramic crowns appeared to exhibit sufficient strength values to allow clinical evaluation. Conclusion: All-ceramic crowns exhibited far superior translucency than metal ceramic crowns.

Key Words: Ceramic Crowns; Metal Ceramic Crowns; Translucency; Fracture Strength.

Received on: 30/06/2010 Accepted on: 06/09/2010

Introduction

The science and technology with its array of inventions and discoveries in the material science along with art and culture in its divergent forms have contributed greatly in the quest of achieving esthetic excellence. In prosthodontics porcelain has found primadonna position in achieving esthetic realism.

The composition and formulae of dental porcelain have been continuously evaluated and modified to improve its strength and enhance its physical properties. Improved leucite porcelain and bonding ceramic to metal was described by Weinstein and colleagues in 1962. (1) This led to the advent of metal ceramic restorations. Metal ceramic restorations are highly popular and most widely used in fixed prosthodontics today.

Though metal ceramic restorations are much stronger than what is required clinically, its metallic substructure does pose some limitations like lack of depth in translucency, metallic collar hampering esthetics in marginal gingival area and the metallic feeling.

Limitations of metal ceramic restorations prompted developments of all-ceramic products with excellent esthetic capability. Newer all-ceramic restorations include alumina reinforced core porcelain by McLean and Hughes 1965(2) magnesia core porcelain by O’Brien 1983,(3) injection molded aluminoous porcelain, castable glass ceramics, slip cast ceramics, etc. These all-ceramic restorations have broadened the choices for esthetic dentistry often prompting overly optimistic and promising literature, their strength is still an important issue. The study was planned to evaluate translucency in terms of percentage of light transmission and fracture strength of two all-ceramic systems viz conventional sintered all-ceramic and slip cast all-ceramic (Vita Inceram) and traditional metal ceramic crowns.

Materials and Methods

Many methods have been used to determine relative strengths of ceramic and ceramo-metal crowns. Method used for this study was modified Warpeha Goodkind test method(4) in which the ceramic crowns were fractured in an attempt to simulate truer prosthetic configuration of the components. To standardize the crown fabrication typodont model (Ivoclar) was used. Right maxillary central incisor was prepared with a 5° convergence, 1.2 mm wide shoulder axio-icisal and axio-gingival line angles were rounded.

An impression of prepared tooth was made with an addition silicone material from which Nickel-chromium base metal alloy master dies were cast and finished. The master die was also duplicated with addition silicone to form working dies. Dies were removed after two hours and examined for satisfactory reproduction. On these working models ten crowns of each of three ceramic systems viz Vita Inceram, conventional all-ceramic and traditional metal ceramic were fabricated.

Testing of Specimens:
1. Evaluation of the translucency: The translucency (percentage of light transmission) was evaluated by UV spectrophotometer 260 (Shimadzu, Japan). Freshly extracted maxillary...
central incisors were used as control sample. Visible light frequency range of 400-750 nm was
used to find out percentage of light transmission.
2. Evaluation of Fracture Strength: After glazing six out of ten crowns of each system were cemented on master Ni-Cr alloy die with quick setting zinc-phosphate cement (Harvard cement, Richter Co., Germany). The master die was fabricated in such a way that the long axis of the crown was perpendicular to floor and incisal edge parallel with the floor. After 30 min of cementation, crowns were tested in microprocessor based universal testing machine (Schenk Trebel, Germany) with cross head speed of 0.05 in/min. The incisal edge of crown was loaded with rounded chisel (radius 1.5mm) until crack appeared or veneer fractured. Four crowns of each of the ceramic systems were loaded directly under the testing machine without cementation on master die to find out effect of cement on fracture strength. The results obtained after compressive load test were subjected to statistical analysis.

Results

Translucency in terms of percentage of light transmission was evaluated by spectrophotometer. Table 1 shows mean percentage of light transmission by 3 ceramic system crowns and freshly extracted maxillary incisors.

Table 1 Mean % of Light Transmission (%)

<table>
<thead>
<tr>
<th>Specimen</th>
<th>λ750</th>
<th>λ400</th>
<th>λ550</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Tooth</td>
<td>86</td>
<td>44</td>
<td>68</td>
</tr>
<tr>
<td>Conv. All Ceramic</td>
<td>78</td>
<td>27</td>
<td>62</td>
</tr>
<tr>
<td>Vita Inceram</td>
<td>74</td>
<td>25</td>
<td>62</td>
</tr>
<tr>
<td>Metal Ceramic</td>
<td>64</td>
<td>20</td>
<td>52</td>
</tr>
</tbody>
</table>

Conventional all-ceramic crowns and Vita Inceram crowns exhibited more natural translucency than the metal ceramic crowns. And the translucency was identical with the natural teeth. The fracture strength of three ceramic crowns was investigated by compressive load test in Universal testing machine. Means and standard deviations for the cemented experimental groups are listed in Table 2.

Table 2 Mean fracture loads of cemented crowns (Newton N)

<table>
<thead>
<tr>
<th>Specimen</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vita Inceram</td>
<td>4</td>
<td>815</td>
<td>±17</td>
</tr>
<tr>
<td>Conv. All Ceramic</td>
<td>4</td>
<td>408</td>
<td>±16</td>
</tr>
<tr>
<td>Metal Ceramic</td>
<td>4</td>
<td>2410</td>
<td>±18</td>
</tr>
</tbody>
</table>

Means and standard deviations for uncemented groups are listed in Table 3.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inceram -&gt; Conv. All-Ceramic</td>
<td>p&lt;0.01</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Metal Ceramic -&gt; Inceram</td>
<td>p&lt;0.01</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Metal Ceramic -&gt; Conv. All Ceramic</td>
<td>p&lt;0.001</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Inceram -&gt; Inceram</td>
<td>p&lt;0.01</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Conv. All-Ceramic -&gt; Conv. All Ceramic</td>
<td>p&lt;0.01</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Metal Ceramic -&gt; Metal Ceramic</td>
<td>p&gt;0.05</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

The statistical evaluation was completed using an ANOVA and paired comparison in Table 4.

Discussion

Translucency of dental enamel has been measured by use of spectrophotometer(5) and it is function of wavelength. Higher the wavelength, higher the light transmission and higher will be translucency. Metal ceramic has defective translucency without natural depth as compared to all-ceramic crowns, owing to substantial opaque metal framework and highly reflective opaque layer of porcelain. Transmission of light occurs only in incisal layer. In contrast opaque porcelain in all-ceramic crowns has diffuse transmissibility and low reflectivity which permits considerable penetration of light which in turn increases translucency.

Fracture of dental porcelain is perplexing reality in dentistry. Compressive strength studies give an idea for load bearing capacity in
simulated clinical situations. The metal ceramic crowns had significantly greater fracture resistance than any of the all-ceramic units. Amongst all-ceramics, Vita Inceram crowns had higher fracture resistance than conventional all-ceramics crowns. These findings are in agreement with other studies with similar methodology(6). Porosity is important factor in determining all-ceramic material’s resistance to stress(7). Vita Inceram crowns is infiltrated with molten glass providing homogenous, bubble-free tough core resulting in greater stress resistance.

In case of metal ceramics, metallic substructure’s high coefficient of elasticity gives increased resistance to stress which limits extension of cracks to superficial layer. Significant increase in fracture strength of both of the all-ceramic crowns after luting with luting cement (zinc phosphate) is in agreement with other studies(8),(9). As the mean chewing forces occurring in humans are approx 40 N(10) and mean maximum forces between antagonist teeth range between 245 N and 540 N, it may be stated that both of the all-ceramic crowns have sufficient strength to allow clinical testing. A higher risk of fracture is expected for molar restorations with conventional all-ceramic crowns.

**Conclusions**

Within the limitations of this study designs following conclusions were drawn.

1) All-ceramic crowns were more translucent than metal ceramic crowns and their translucency was identical with natural teeth

2) In all-ceramic crowns, Vita Inceram crowns exhibited significantly higher fracture strength than conventional all-ceramic crowns.

3) Metal ceramic crowns were significantly more resistant to fracture than any of the two all-ceramic crowns.

4) Cementation with zinc phosphate cement significantly increased fracture strength of two all-ceramic crowns.

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**Acknowledgement**: All staff members of Dept. of Prosthodontics, College of Dental Science & Hospital, Rau, Indore (M.P.), India.

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Source of Support: Nil, Conflict of Interest: None Declared