Cumulative Effects of Successive Restorative Procedures on Anterior Crown Flexure: Intact Versus Veneered Incisors

Magne P. Douglas WH.

Figure 3-22:
Figure 3-23:

Table 11-19: Hard Tissue Removal from Incisors

Mean (s.d.) Fracture Strength

Conclusion

- Each subsequent reduction in tooth structure resulted in a substantial increase in crown flexibility, even after restoration.
- Endodontic procedures were responsible for most of the loss in crown stiffness.
- Extensive proximal cutting and restorations seemed to minimally affect crown flexure.
- Porcelain veneers showed perfect biomimetic behavior, because cumulated restoration procedures had the same effect on natural and veneered incisors.
Anterior Preparation Designs

**ADHESIVELY RETAINED**

1. **Facial Veneer / Prepless**
   - Feldspathic

2. **Facial Veneer / Incisal Reduction Butt Joint**
   - Feldspathic
   - EMAX

3. **Facial Veneer / Incisal Reduction Lingual Chamfer**
   - Feldspathic
   - EMAX

4. **Full Veneer Preparation**
   - Feldspathic
   - EMAX

**COHESIVELY RETAINED**

5. **Full Coverage Conservative Preparation**
   - EMAX only

6. **Full Coverage Conventional Preparation**
   - EMAX
   - Zirconia
   - Metal Ceramic

7. **Full Coverage Agressive Preparation**
   - EMAX
   - Zirconia
   - Metal Ceramic
Adhesively Retained

Reference

Fracture Load and Mode of Failure of Ceramic Veneers with Different Preparations

Castelnuovo J, Tjan AHL, Phillips K, Nicholls JI, Kois JC.


Mean (s.d.) Fracture Strength

Conclusion

- Ceramic veneers with 2.0 mm of unsupported incisal ceramic and butt joint and ceramic veneers with feathered incisal edge were the strongest and remained intact.
- A palatal chamfer did not provide increased strength for ceramic veneers.
- On the basis of this in vitro investigation, fractured teeth with up to 4.0 mm of missing tooth structure can be restored with leucite-reinforced ceramic veneers.
- The fracture load values recorded were comparable to more conservative designs in relation to the amount of unsupported incisal ceramic.
- Ceramic veneers with incisal butt joint offered several clinical advantages such as tooth preparation, ceramic veneer fabrication, manipulation, and insertion.
Influence of Preparation Design and Existing Condition of Tooth Structure on Load to Failure of Ceramic Laminate Veneers


Table 4-1: Mean (SD) of Load to Failure and Remaining Enamel Thickness on Incisodental Surface. For Mode of Failure: Type I: Cohesive Failure with Veneer Fracture; Type II: Mixed Failure; Type III: Adhesive Failure; Type IV: Root Fracture

<table>
<thead>
<tr>
<th>Group</th>
<th>Remaining Enamel Thickness (mm)</th>
<th>Load to Failure (N)</th>
<th>Mode of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Shoulder Finish Line</td>
<td>0.68 (0.18)a</td>
<td>131.84 (18.88)b</td>
<td>62.5</td>
</tr>
<tr>
<td>(Non-worn Tooth)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palatal Chamfer</td>
<td>0.60 (0.08)a</td>
<td>166.67 (28.89)a</td>
<td>87.5</td>
</tr>
<tr>
<td>(Non-worn tooth)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder Finish Line</td>
<td>0.49 (0.05)b</td>
<td>90.56 (9.32)c</td>
<td>37.5</td>
</tr>
<tr>
<td>(Wear tooth)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palatal Chamfer</td>
<td>0.44 (0.04)b</td>
<td>119.55 (23.88)b</td>
<td>37.5</td>
</tr>
<tr>
<td>(Wear tooth)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values with same lowercase letter are not significantly different at P<.05

Conclusion

Preparation design and the amount of existing tooth structure had a significant effect on load to failure for ceramic veneers. This study revealed that using a palatal chamfer margin design significantly increased the load to failure compared to a shoulder finish line.
The choice of an appropriate restorative material to be used as the foundation restoration for an endodontically treated tooth has become more complex. The structural concerns of the remaining tooth structure must be carefully evaluated and weighed against the esthetic needs of the patient.

Conclusion

Endodontically treated molars with a conservative endodontic access, or after removal of all cusps restored to original contour with amalgam, presented the highest resistance to fracture under a simulated occlusal load.
Cuspal Deflection

Reference

Effect of Prepared Cavities on the Strength of Teeth
Larson TD, Douglas WH, Geistfeld RE.

Table 3-5: Load Required to Fracture Teeth

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Cavity</td>
<td>530</td>
<td>(238.5) 119.3</td>
</tr>
<tr>
<td>1/4 ICD / MOD</td>
<td>334</td>
<td>(150.3) 115.6</td>
</tr>
<tr>
<td>1/4 ICD / OCC</td>
<td>333</td>
<td>(149.9) 112.4</td>
</tr>
<tr>
<td>1/3 ICD / MOD</td>
<td>216</td>
<td>(97.2) 62.8</td>
</tr>
<tr>
<td>1/3 ICD / OCC</td>
<td>213</td>
<td>(95.9) 66</td>
</tr>
</tbody>
</table>

Joins Pairs that are not significantly different.

Conclusion
The width of the occlusal portion of a preparation affects the strength.
CRACKED TOOTH SYNDROME

Reference

Premolar Cuspal Flexure as a Function of Restorative Material and Occlusal Contact Location

Magne P, Oganesyan T.

Figure 3-27: Congruent STL parts of enamel and dentin resulting from Boolean intersections and subtractions between the original enamel/dentin STLs and different CAD inserts. The final model of the tooth is an assembly of 4 different parts. Different material properties can be attributed to the dentin and enamel inserts, resulting in 3 possible models, i.e., the natural tooth (NAT), MOD porcelain restoration (CER), and MOD composite resin restoration (CPR).

Figure 3-28: Cusp widening results. Force generated by the load sphere in newtons versus cuspal widening in millimeters for each experimental design.

Figure 3-29: Possible ball contacts during loading. (E) Enamel contacts with large, 9.5-mm ball; (M) contacts at restoration margin with the medium, 6.5-mm ball; @ contacts in restorative material with small, 4.5-mm ball.

Figure 3-30: Load protocol and configuration as seen in Mentat, i.e., a nonlinear contact analysis between a rigid body (sphere moving along Z-axis against the tooth) and a deformable tooth. The widening of the cusps (ΔV) was calculated from the output values of displacement along the Y-axis for selected nodes near the cusp tip.

Figure 3-31: Buccolingual cross-section views of the first principal stress distribution in 5 of the 9 models studied (load increment closest to 100 N).

Conclusion

These models revealed high cuspal strains associated with mesio-occlusodistal preparations and restorations compared to individual two-surface preparations. Whenever possible during removal of interdental decay, an intact marginal ridge should be maintained to avoid three-surface preparations such as the mesio-occlusodistal.
A Comparison of Various Preparation Designs for Adhesively Retained Posterior Ceramic Onlays

Kois DE.
Presented in part at the Annual Scientific Meeting of the American Academy of Restorative Dentistry.

1. Key Tooth Preparation Design Elements

Figure 6-57: A & B: Structural – 2 mm Occlusal Reduction (Substrate Specific), Contact Preservation (Optional).

Figure 6-58: A & B: Mechanical – Positive Seat.

Figure 6-59: Biological – Enamel Ring Concept.
A Comparison of Various Preparation Designs for Adhesively Retained Posterior Ceramic Onlays: A Fatigue Load Study

Kois DE, Chaiyabutr Y, Phillips KM, Kois JC.
First Place Winner Graduate Prosthodontic Resident Research Award. Presented in part at the 73th Annual Scientific Meeting of the Pacific Coast Society for Prosthodontics, June 2008, Kona, Hawaii.

**Figure 4-3:** Preparation design for MOD gold onlay: Occlusal View.

**Figure 4-4:** Preparation design for MOD gold onlay: Proximal View.

**Figure 4-5:** Preparation design for 2mm TT.

**Figure 4-6:** Preparation design for 2mm TT/VNR.

**Figure 4-7:** Preparation design for 4mm TT.

**Figure 4-8:** Preparation design for 4mm TT/VNR.

**Figure 4-9:** Mean and SD of preliminary failure cycle counts (x10^3).

**Figure 4-10:** Mean and SD of catastrophic failure cycle counts (x10^3).
Conclusion

1. Preparation design had a significant (P < 0.05) effect on number of cycles to preliminary and complete failure for posterior adhesively retained ceramic onlays.

2. The 4 mm occlusal reduction experimental onlays (4 mmTT, 4 mmTT/VNR) displayed a statistically significant lower number of cycles to failure than all other groups.

3. In all ceramic onlay groups, the buccal veneer component made no statistically significant difference.

4. Catastrophic (ceramic fracture) failures occurred only in the 4 mm vertical reduction experimental groups (4 mmTT, 4 mmTT/VNR).

5. A significant (P < 0.05) difference in enamel ring thickness was revealed between 2 mm and 4 mm occlusal reductions.

Clinical Implications

When vertical posterior tooth preparation depth minimizes enamel ring thickness (< 1 mm) and involves compromised dentin structure, adhesively retained restorative solutions are not recommended.
Reference

Marginal Quality and Fracture Strength of Root-Canal Treated Mandibular Molars with Overlay Restorations after Thermocycling and Mechanical Loading

Dere M, Ozcan M, Göhring TN.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Initial Crack</th>
<th>Loads to Failure (N)</th>
<th>Failure Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean ± SD</td>
<td>Significance*</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>UTR</td>
<td>8</td>
<td>1362 ± 821</td>
<td>B</td>
<td>3048 ± 905</td>
</tr>
<tr>
<td>RCT-COM</td>
<td>8</td>
<td>1942 ± 699</td>
<td>AB</td>
<td>2770 ± 457</td>
</tr>
<tr>
<td>RCT-FRC</td>
<td>8</td>
<td>2446 ± 432</td>
<td>A</td>
<td>3619 ± 520</td>
</tr>
<tr>
<td>RCT-CER</td>
<td>8</td>
<td>1800 ± 277</td>
<td>AB</td>
<td>2036 ± 319</td>
</tr>
</tbody>
</table>

*No statistical significant differences were found in groups with the same letters (P < 0.05).

Conclusion

Composite resin restorations (Class II cavities) with and without glass-fiber reinforcement performed similar to intact teeth. Failure types, however, varied between the restorative materials. While intact teeth failed exclusively in reparable modes, all other restorations (except for half of the fiber reinforced composite group) failed in a catastrophic manner.