# *TRABAJO DE FIN DE GRADO*

## *Grado en Odontología*

# *“INCRUSTACIONES, TIPOS DE PREPARACIÓN Y MATERIALES, VENTAJAS E INCONVENIENTES”*

**Madrid, curso 2020-2021**

Número identificativo **77**

**RESUMEN ESTRUCTURADO**

***Objetivos***. Realizar una revisión bibliográfica sobre los distintos tipos de incrustaciones atendiendo al tipo de preparación y analizando las indicaciones, longevidad y tipos de materiales.

***Metodología.*** Se realizó una búsqueda bibliográfica utilizando artículos de alto impacto de los últimos 5 años seleccionados en revistas de prestigio. Palabras: inlay, onlay, inlay, overlay, tipos de preparaciones y materiales cerámicos.

***Resultados***. El disilicato de litio presenta mayor traslucidez, sigue la zirconia 5Y-ZP y la zirconia 3Y-TZP. La resistencia a la flexura es menor para el disilicato de litio y mayor para la zirconia 3Y-TZP. La zirconia 5Y-ZP presenta resistencia intermedia. Vita Enamic y Lava Ultimate presentan mayor desgaste si se comparan con Vita Mark II. El material más frágil es el IPS Empress CAD, sigue el IPS e.max CAD que presenta una tasa de supervivencia del 30% mientras que Paradigm MZ100 presenta una tasa de supervivencia del 100 %. Sobre 610 incrustaciones realizadas con disilicato de litio (IPS e.max Press), 6 muestran fracasos y presentan una tasa de supervivencia a los 10.5 años de 95.27%. 189 restauraciones realizadas en composite, presentan una tasa de supervivencia del 96,8% y una tasa de supervivencia funcional del 98,9% durante un periodo de seguimiento de 24 meses hasta 52.

***Conclusiones.*** Las incrustaciones se clasifican en inlay, onlay, endocrown, overlay, overlay adicional, carillas oclusales, veneerlay y long wrap overlay. Onlay u overlay son de elección para dientes posteriores endodonciados con importante pérdida de sustancia y cantidad adecuada de esmalte cervical. El disilicato de litio y el composite presentan elevada supervivencia. En cuanto al tipo de preparación, según Ferraris el butt joint es de

elección y el bisel en algunos casos. Según Veneziani, el bisel cóncavo es más favorable para la técnica adhesiva. Según Magne, el bisel cóncavo asegura óptima adaptación marginal y estética.


## ABSTRACT

***Purpose.*** Carry out a bibliographic review on the different types of partial indirect restoration according to the type of preparation, analyzing the indications, longevity and types of materials.

***Methodology.*** A bibliographic search was carried out using hight impact scientific articles from the past 5 years selected in prestigious journals. Words: inlay, onlay, inlay, overlay, types of preparations and ceramic materials.

***Results.*** Lithium disilicate shows higher translucency, follows 5Y-ZP zirconia and zirconia 3Y-TZP. Flexural strength is lower for lithium disilicate and higher for zirconia 3Y-TZP. Zirconia 5Y- ZP exhibits intermediate strength. Vita Enamic and Lava Ultimate show higher wear if compared to Vita Mark II. The material more fragile is the IPS Empress CAD, it follows the IPS e.max CAD that presents a survival rate 30% while Paradigm MZ100 presents a survival rate of 100%. Out of 610 inlays made with lithium disilicate (IPS e.max Press), 6 show failures and present a survival rate at 10.5 years of 95.27%. 189 restorations made in composite, present a survival rate of 96.8% and a functional survival rate of 98.9% during a follow-up period of 24 months up to 52.

**Conclusions.** Inlays are classified into inlay, onlay, endocrown, overlay, additional overlay, occlusal veneers, veneerlay, and long wrap overlay. Onlay or overlay are the

choice for teeth with endodontic treatment with important loss of substance and adequate amount of cervical enamel. The lithium disilicate and the composite show a high survival rate. Regarding the type of preparation, Ferraris followed the butt joint is of choice and the bevel in some cases. According to Veneziani, the bevel concave was favored by the adhesive technique. According to Magne, the concave bevel ensures optimal marginal and aesthetic adaptation.

**ÍNDICE PAGINADO**


**1. INTRODUCCIÓN**

**a. Definición** *Pág.1*

**b. Ventajas** *Pág.1*

**c. Tipos de incrustaciones** *Pág.2*

**d. Indicaciones** *Pág.4*

**e. Contraindicaciones** *Pág.6*

**f. Principios de preparación cavitaria** *Pág.7*

**g. Tipos de preparaciones** *Pág.8*

**h. Materiales** *Pág.12*

**i. Métodos y técnicas de fabricación** *Pág.16*

**j. Cementación** *Pág.18*

**2. OBJETIVOS** *Pág.19*

**3. METODOLOGÍA**

**a. Análisis de búsqueda de estudios y recogida de datos** *Pág.20*

**b. Criterios de inclusión y exclusión** *Pág.21*

**4. DISCUSIÓN DE RESULTADOS**

**a. Tipos de materiales** *Pág.21*

**b. Resistencia de los materiales** *Pág.24*

**c. Método de fabricación y tipos de impresiones** *Pág.26*

**d. Tipos de preparaciones** *Pág.28*

**e. Protocolo de cementación** *Pág.29*

**f. Supervivencia en el tiempo** *Pág.31*

**5. CONCLUSIONES** *Pág.34*

**6. RESPONSABILIDAD SOCIAL** *Pág.35*

**7. BIBLIOGRAFÍA** *Pág.36*

**8. ANEXOS** *Pág.42*

# 1. INTRODUCCIÓN

## A. DEFINICIÓN

La moderna odontología conservadora aspira a la preservación de la estructura dental remanente, protegiendo la vitalidad pulpar, evitando un posible tratamiento de conductos (1) y buscando un planteamiento mini-invasivo (2). Se denomina "restauración indirecta adhesiva" una restauración parcial de la corona, realizada en los sectores posteriores, que se distingue por una geometría cavitaria con características peculiares que se desarrollarán posteriormente (3). A diferencia de las anteriores incrustaciones en metal, que se basaban en una cavidad retentiva (2), las actuales incrustaciones estéticas se caracterizan por una cementación de tipo adhesivo (4).

## B. VENTAJAS

Actualmente, la evidencia científica se inclina a favor de las incrustaciones estéticas (2).

Los motivos de esta elección engloban, la escasa o nula invasividad, los excelentes parámetros estéticos y la capacidad de consolidar la estructura dental sana remanente, favoreciendo el refuerzo del diente comprometido (2). La literatura afirma que las incrustaciones preservan un 50% más de la estructura dental en comparación con una corona de metal porcelana (1)(5). Además, son más conservadoras también en cuanto al restablecimiento de la anchura biológica perdida, ya que no necesitan un efecto abrazadera imprescindible para las coronas totales (5) y tampoco requieren cavidades invasivas a diferencia de las anteriores restauraciones metálicas (2). Se define efecto abrazadera a la

estructura dental vertical remanente a nivel coronal cuyo valor como mínimo tiene que ser 2 mm (5)(6).

A partir de los últimos diez años ha aumentado la demanda de las incrustaciones estéticas debido a diversas razones entre ellas cabe destacar (7):

- Las innovaciones en los procedimientos adhesivos (3)(8);
- Las innovaciones en los materiales (8);
- El objetivo de preservar el tejido dental (principio de bioeconomía), ser mínimamente invasivos y reforzar la estructura remanente (2)(8);
- El aumento de la demanda de restauración sin metal (7) y el creciente interés por la estética (2)(7)(8);
- Supervivencia a largo plazo (1).

## C. TIPOS DE INCRUSTACIONES

Ateniéndose a las restauraciones indirectas convencionales, existen tres tipos y se clasifican en inlay, onlay u overlay (3).

Se define inlay una restauración indirecta parcial que no cubre las cúspides (3). Se trata de onlay si hay al menos una cúspide recubierta y si todas las cúspides han sido recubiertas se habla de overlay (3).

Ateniéndose a las recientes incrustaciones desarrolladas, se clasifican en overlay adicional, carillas oclusales, veneerlay y long wrap overlay (3).

El overlay adicional no necesita ningún tipo de preparación y está indicado en casos de erosiones o abrasiones o si hay necesidad de modificar la dimensión oclusal (3).

Las carillas oclusales (table top) se caracterizan por una preparación no retentiva y presentan las mismas indicaciones de los overlay adicionales (3). Se consideran restauraciones extracoronales y el espesor recomendado para la cerámica es de 1,5-2 mm (1).

La restauración tipo veneerlay está compuesta por un overlay y una carilla que engloba la pared bucal y está indicada en los casos de dientes posterosuperiores con un mal sustrato e implicaciones estéticas, como por ejemplo los premolares superiores (3).

El long - wrap overlay engloba la superficie oclusal, vestibular y/o palatina o lingual y está indicado en lesión cariosa muy extensa, abrasiones o fracturas en la superficie externa (3).

*Figura 1: Long-wrap overlay* (3). *Página 23.*

Otro tipo de restauración parcial indirecta para los sectores posteriores es el endocrown, una restauración monolítica adhesiva cuya peculiaridad consiste en el anclaje interno a la cámara pulpar de los dientes endodonciados para aportar retención previniendo además el

riesgo de contaminación durante la retirada parcial de la gutapercha para la posterior colocación del poste (9)(10) .

Por lo tanto, combina la corona y la reconstrucción del muñón en un único elemento monobloc (6).

A diferencia de la corona de recubrimiento total, las restauraciones adhesivas y por tanto también el endocrown, no necesitan de un efecto abrazadera (5). En caso de que haya márgenes yuxtagingivales y dificultad para alcanzar el efecto ferrule o que esto suponga un ulterior deterioro del diente convertiendolo en no restaurable, se optará por un endocrown en lugar de una corona (10).

Otra ventaja que presenta el endocrown engloba el menor grado de invasividad respecto a la colocación de un poste, reconstrucción del muñón y corona y por lo tanto conlleva menor tiempo de trabajo (6).

## D. INDICACIONES

En la actualidad, las indicaciones de las incrustaciones no se limitan al tratamiento de los dientes afectados por caries, sino que incluyen las fracturas y los desgastes dentales (11), también están indicadas en casos de erosión, síndrome del diente agrietado (1) (12) y en las rehabilitaciones orales para restaurar la dimensión vertical perdida, siendo más conservadoras respecto a una corona total (12).

En los pacientes que presentan erosión dental severa, convencionalmente se optaba por una rehabilitación de ambas arcadas, mediante coronas de recubrimiento total, pero en la actualidad, gracias a la técnica Three Step ideada por Vailati, es posible un planteamiento

más conservador con técnicas adhesivas, usando onlays en la región posterior y carillas en porcelana en vestibular y en palatino en la región antero superior (13).

Las incrustaciones desempeñan un papel importante en la sustitución de anteriores restauraciones deterioradas (11) y constituyen una opción viable en los casos de clase II amplia de tipo onlay (3). La restauración del diente endodonciado juega un papel fundamental, ya que la principal causa de fracaso presenta origen protésica(5). El diente endodonciado debido a las modificaciones biomecánicas a las cuales ha sido sometido durante y como consecuencia del tratamiento de los conductos, se vuelve más frágil y susceptible a las fracturas y por lo tanto es necesario protegerlo mediante restauraciones coronales (2) (10). Se recomienda el uso de las incrustaciones en los casos en que se necesite llevar a cabo múltiples restauraciones en varios cuadrantes o donde se requiera modificar la dimensión oclusal (3), además en casos de márgenes subgingivales se prefiere una restauración indirecta respecto a una directa (11). Las paredes remanentes y la posición del diente en la arcada, influyen en la elección del tipo de tratamiento a realizar (5). La presencia de una cantidad adecuada de esmalte cervical y de sustancia dental residual es crucial para el diagnóstico y el tratamiento, de hecho, si el diente presenta una cantidad suficiente de esmalte cervical, el tratamiento adecuado será una incrustación y, en caso contrario, una corona de recubrimiento total (5).

Teniendo en cuenta la cantidad de tejido dental, las paredes restantes y la presencia o no de fisura, se realiza en diente endodonciados (5):

- Una incrustación tipo inlay en el caso de la cavidad mesio-oclusal o disto-oclusal con cúspides y cresta marginal con un espesor superior a 2,5 mm, cantidad inadecuada de esmalte cervical y en ausencia de fisuras (5). En ausencia de esmalte cervical, se prefiere una restauración indirecta debido a la mínima contracción de polimerización, limitada al

material de cementación (5). En presencia de cantidad adecuada de esmalte cervical, se opta por una restauración con técnica directa en composite (5).

Una incrustación tipo inlay representa una situación clínica poco frecuente (5), de hecho está indicada en dientes vitales en caso de clases II medio-amplia (3);

- Una incrustación tipo onlay en el caso de amplia cavidad mesio-oclusal o disto-oclusal con espesor de las cúspides adyacentes a la cresta marginal comprometida de espesor insuficiente y espesor de las cúspides adyacentes a la cresta marginal no comprometida, de espesor superior a 2,5 mm, sin fisuras (5);

- Una incrustación tipo overlay en caso de cavidades mesio-ocluso-distal con o sin fisuras y en presencia de cantidad adecuada de esmalte cervical (5). En general, siempre que el diente presente grietas se debe utilizar un overlay (5).

## E. CONTRAINDICACIONES

Las incrustaciones están contraindicadas en los siguientes casos (14):

- Higiene oral deficiente (14);
- Poco esmalte remanente y por lo tanto mala adhesión (14);
- Dientes que presentan una marcada alteración del color (14);
- Dientes que puedan ser restaurados mediante la utilización de una técnica directa que presente menor invasividad (14);
- En los pacientes bruxistas que no quieren usar una férula de descarga. En estos casos se recomienda usar como material resina indirecta polimerizada en laboratorio que presenta

menor riesgo de fractura respecto a la cerámica (14). En los últimos años, gracias a la mejoría de los materiales, se disponen de una mayor gama de productos (15).

En pacientes con parafunción y con antagonista de dientes naturales se recomienda el uso de cerámicas con matriz de resina, a pesar del mayor desgaste que presentan respecto a los materiales cerámicos (16). La elección de las cerámicas con matriz de resina se debe al menor desgaste que causan al diente antagonista (16). Según Veneziani, en caso de que el paciente presente una parafunción o con espacio oclusal reducido menor de 1 mm, el oro resulta un material válido (8).

## F. PRINCIPIOS DE PREPARACIÓN CAVITARIA

El diseño cavitario sigue los siguientes parámetros:

- La cavidad debe tener paredes lisas con una divergencia de unos 6-10 grados hacia el exterior para una correcta vía de inserción (3)(5);
- En el caso de cavidades profundas en dientes endodonciados, el uso de cemento de vidrio ionómero tiene como objetivo cubrir el piso pulpar y facilitar un eventual retratamiento endodóncico (7). Se recomienda una capa de composite, también en los dientes vitales, para reducir el volumen de la restauración y favorecer una preparación con una correcta geometría (7);
- Los contactos oclusales no deben recaer sobre los márgenes de la restauración (3);
- Los ángulos internos deben ser redondeados (3)(5)(12);
- Es necesario acabar en esmalte con márgenes netos (5);

- Reducir las cúspides de 1,5-2 mm (5). El espesor del material de la restauración debe ser para el composite y para el disilicato de litio 1-1,5 mm y para la cerámica feldespática y la cerámica con matriz vítrea reforzada con leucita 2-2,5 mm (3);
- El istmo oclusal deberá tener una anchura y una altura de 2 mm (3)(5);
- Es necesario, para mantener las paredes, tener un espesor mínimo de 2 mm si el diente está vital (la literatura reciente afirma 1 mm) y mayor de 3 mm si el diente está endodonciado (3);
- Eliminar los socavados y las zonas retentivas (12), conseguir una correcta geometría de la cavidad y por lo tanto obtener un espesor óptimo del material restaurador que permita la correcta polimerización del agente cementante (3);
- Falta de contacto entre la cavidad y el diente adyacente (17);
- Comprobar que haya suficiente espacio interoclusal durante los movimientosen céntrica y excéntricos (17);
- A la hora de realizar una restauración tipo overlay, es indispensable seguir la anatomía oclusal y los surcos secundarios (7).

## G. TIPOS DE PREPARACIONES

Hoy en día las preparaciones tienen como objetivo minimizar la perdida de tejido dental sano para aportar resistencia al tejido dental remanente y facilitar las técnicas adhesivas (8).

Se diferencian tres tipos de preparación: butt joint, bisel y hombro (12).

Para realizar el butt joint se necesita seguir la inclinación del plano oclusal, excepto en la línea de terminación donde la preparación será más horizontal (12).

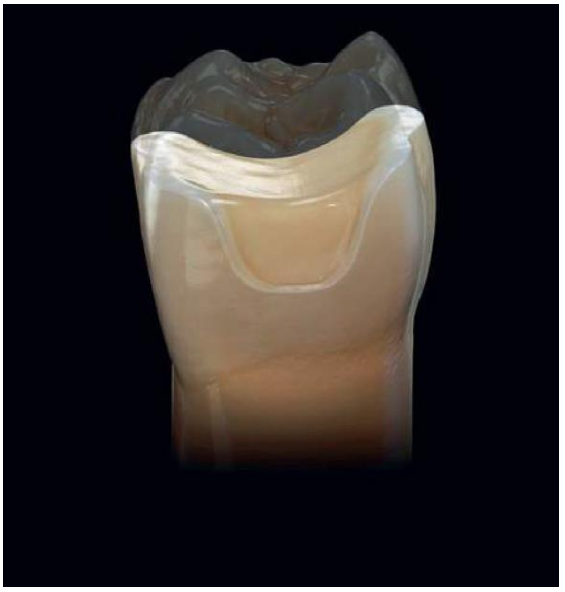


*Figura 2. Butt Joint* (12). *Página 492.*

El butt joint está indicado sobre todo en los casos de sobrecarga oclusal, abrasión o erosión, fractura cuspídea y en caso de carillas oclusales (12).

Única diferencia entre el butt joint y el bisel consiste en la presencia de un bisel inclinado de 45 grados o más con una anchura que oscila entre 1-1,5 mm (12).

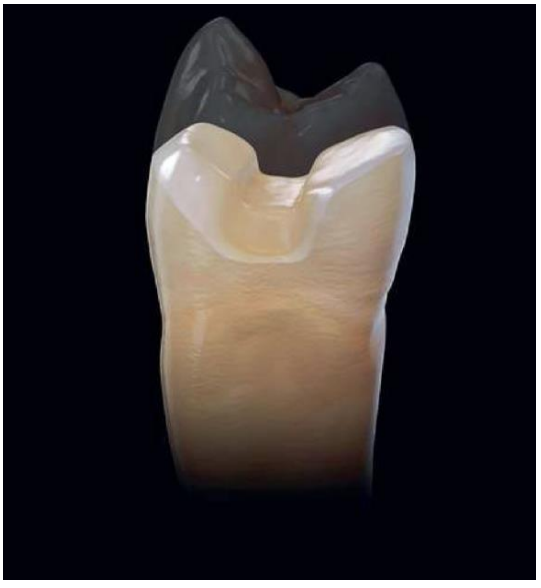


*Figura 3. Bisel* (12). *Página 493.*

El autor Veneziani indica un nuevo tipo de preparación llamada bisel cóncavo o hollow chamfer (3). Se trata de un tipo de preparación que se realiza en las paredes axiales si se encuentran coronales respecto a la línea de máximo contorno dentario (3). El bisel cóncavo consiste en una preparación con plano inclinado (3).

Otro tipo de preparación es el hombro redondeado de 1 mm (12).

*Figura 4. Hombro (12). Página 493.*

En cuanto a los tipos de preparaciones de las superficies interproximales, se clasifican en slot, bisel y ridge up (12). El slot, muy común, presenta un hombro redondeado de 1 mm y el diseño sigue la remoción de la caries en el espacio interproximal (12).

*Figura 5. Slot (12). Página 495.*

En el caso de que no haya caries en el punto de contacto y haya necesidad de poner una incrustación, se optará para realizar un bisel, más conservador respecto a la preparación precedente y con la ventaja de facilitar las técnicas adhesivas (12).

*Figura 6. Bisel* (12). *Página 495.*

La preparación ridge up preserva la cresta marginal, requiere una mínima preparación y presenta un enfoque muy conservador, conforme a los principios de las técnicas adhesivas (12).

*Figura 7. Ridge up* (12). *Página 496.*

## H. MATERIALES

Debido a los grandes avances en los materiales hoy en día se dispone de una mayor gama de productos con características diferentes y por lo tanto también el clínico tiene más opciones (15).

En general, hoy en día para la confección de incrustaciones se usan (15):

- Cerámicas con matriz vítrea;
- Cerámicas policristalinas;
- Cerámicas con matriz de resina.

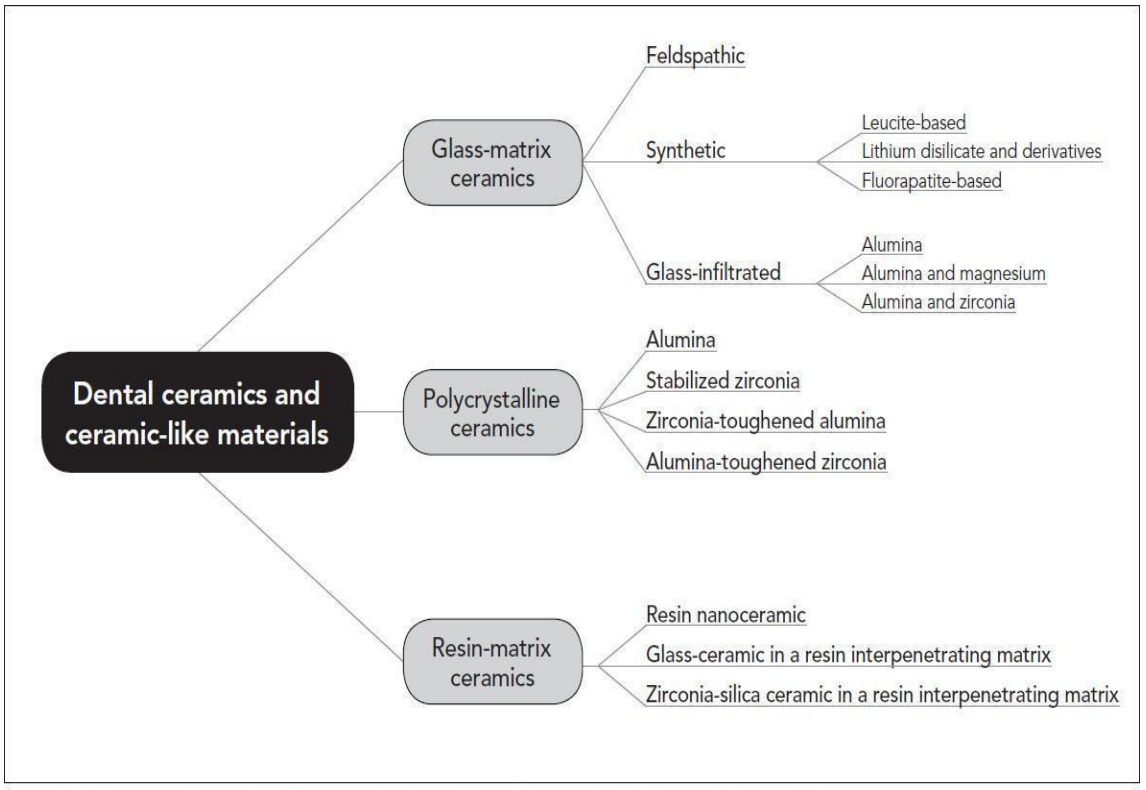



**Fig 1** Overview of the proposed classification system of all-ceramic and ceramic-like materials.

*Figura 8: Clasificación de las cerámicas y materiales cerámicos.* (15). *Página 229.*

A diferencia de las cerámicas con matriz vítrea, las policristalinas no presentan una matriz a base de vidrio en su composición (15). Las cerámicas que contienen matriz de resina a

partir del 2013 han sido incluidas dentro las cerámicas debido a que en su composición hay una matriz orgánica con partículas cerámicas, este grupo de materiales permite reparaciones y fresado más fáciles debido a las características del material y un módulo de Young con pocas diferencias respecto a los valores que presenta la dentina (15).

Dentro de las cerámicas de matriz vítrea que se utilizan hoy en día para la confección de incrustaciones hay (15):

- Cerámicas a base de leucita. Se incluyen en este grupo Noritake Súper Porcelain EX- 3 (15) e IPS Empress CAD (1);
- Cerámica feldespática. Se incluye en este grupo Vitablocs (15). La cerámica feldespática se puede usar para restauraciones indirectas posteriores (3);
- Disilicato de litio (IPS e.max Press e IPS e.max CAD) (15).

Las cerámicas a base de leucita están compuestas por cristales de leucita englobados en sílice amorfa y presentan un módulo de Young de 65-69 GPa y resistencia a la flexión no elevada (18).

El disilicato de litio es dos veces más resistente a la flexión respecto a las cerámicas a base de leucita y presenta un módulo de Young de 103 GPa (18). Además el disilicato presenta buenas propiedades físicas y estéticas (19).

Dentro de las cerámicas policristalinas que se utilizan hoy en día para la confección de incrustaciones hay (15):

- Zirconia estabilizada (Prettau Zirconia, Katana Zirconia, Lava Plus) (15);

- Zirconia no estabilizada reforzada de alúmina y la alúmina reforzada de zirconia no estabilizada (15).

La zirconia estabilizada presenta elevada resistencia a la fractura, pero baja translucidez (15).

La gran ventaja que presenta la zirconia es la capacidad de cambiar de fase, en presencia de grietas, pasando de tetragonal a monocíclica, aumentando de volumen y como consecuencia frena las propagaciones de las fisuras aumentando la resistencia a la fractura del material (15). Respecto a la zirconia no estabilizada reforzada de alúmina y a la alúmina reforzada de zirconia no estabilizada se demostró que la adición de la alúmina a la zirconia, aumentaba la resistencia de la alúmina (15).

Dentro de las cerámicas con matriz di resina que se utilizan hoy en día para la confección de incrustaciones hay (15):

- Las resinas nanocerámicas (Lava Ultimate);
- Las cerámicas vítreas infiltradas en una red polimérica de resina (Vita Enamic);
- Las cerámicas zirconia - sílice en una red polimérica de resina (Bloque Paradigm MZ100).

Las resinas nanocerámicas están constituidas por dos componentes, por la mayor parte cerámica (80%) y el resto resina (18). Las partículas que se encuentran son de sílice y de zirconia (18). Presentan un módulo de Young muy bajo (12 GPa) y resistencia a la flexura de 164 MPa (18).

Las cerámicas vítreas infiltradas en una red polimérica de resina se conocen también con el nombre de cerámicas híbridas y están compuestas por mayor parte de cerámica feldespática y óxido de aluminio (86%) y el resto resina (18). La última cerámica de este grupo, está

compuesta por un 60 % o más de contenido inorgánico y diferentes matrices orgánicas con porcentaje de peso de la cerámica variable (15).

A continuación se enseña una tabla donde se resume la clasificación de las cerámicas mediante el uso clínico y método de fabricación.

**Table 1** Classification Summary of All-Ceramic and Ceramic-like Restorative Materials and Overview of Fabrication Methods, Type of Use, Possibility to Be Etched for Adhesive Cementation, and Clinical Indications According to Manufacturers

| | | | | Clinical indications | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fabrication method | Framework (F) Monolithic (M) Veneer (V) | Etchable | Veneer | Partial coverage restoration | Full-crown Anterior (A) Posterior (P) | FPD | Implant abutment |
| **1. Glass-matrix ceramics** | | | | | | | | |
| 1.1. Feldspathic ceramics | Refractory die, platinum foil, press | M/V | Yes | ✓ | | | | |
| 1.2. Synthetic ceramics | | | | | | | | |
| a. Leucite-based | Press or CAD/CAM | F/M | Yes | ✓ | ✓ | ✓(A) | | |
| b. Lithium disilicate and derivatives | Press or CAD/CAM | F/M | Yes | ✓ | ✓ | ✓ (A/P) | 3-unit up to 2nd premolar | ✓ |
| c. Fluorapatite-based* | Press or layering | V | Yes | – | – | – | – | – |
| 1.3. Glass-infiltrated | | | | | | | | |
| a. Alumina | CAD/CAM or Slip-casting | F | Yes | | | ✓ (A/P) | 3-unit anterior | |
| b. Alumina and magnesium | CAD/CAM or Slip-casting | F | Yes | | | ✓ (A) | | |
| c. Alumina and zirconia | CAD/CAM or Slip-casting | F | Yes | | | ✓ (A/P) | 3-unit posterior | |
| **2. Polycrystalline ceramics** | | | | | | | | |
| 2.1. Alumina | CAD/CAM | F | No | ✓ | | ✓ (A/P) | ✓ | |
| 2.2. Stabilized zirconia | CAD/CAM | F/M | No | | ✓ | ✓ (A/P) | ✓ | ✓ |
| 2.3. Zirconia-toughened alumina and alumina-toughened zirconia | CAD/CAM | F/M | No | | ✓ | ✓ (A/P) | ✓ | ✓ |
| **3. Resin-matrix ceramics** | | | | | | | | |
| 3.1. Resin nanoceramics | CAD/CAM | M | No | ✓ | ✓ | ✓ (A/P) | | |
| 3.2. Glass-ceramics in a resin interpenetrating polymer network | CAD/CAM | M | Yes | ✓ | ✓ | ✓ (A/P) | | |
| 3.3. Zirconia-silica in a resin interpenetrating polymer network | CAD/CAM | M | No | ✓ | ✓ | ✓ (A/P) | | |

CAD/CAM = computer-aided design/computer-assisted manufacture; FPD = fixed partial denture.
*Fluorapatite-based ceramics are used as veneering materials over metal alloy or zirconia substructures.

*Figura 9. Clasificación de las cerámicas, mediante uso clínico y método de fabricación* (15). *Página 233.*

## I. MÉTODOS Y TÉCNICAS DE FABRICACIÓN

Las cerámicas policristalinas y las que contienen matriz de resina se fabrican con el método CAD-CAM (15). El método CAD-CAM consiste en el escaneado intraoral, gracias a un software específico sigue la fase CAD (diseño asistido por ordenador) y por último la fase CAM (fabricación asistida por ordenador) donde hay el fresado y por fin la restauración terminada (20). Si el clínico no dispone de un escáner intraoral en la consulta, se pueden tomar las impresiones de forma tradicional y posteriormente el laboratorio hará el escaneado extraoral del modelo de escayola (20).

El método CAD-CAM Chairside presenta varias ventajas entre las cuales cabe destacar (21):

- Elimina el uso de los materiales de impresiones (21);
- No necesita desinfectar la impresión (21);
- No se necesita enviar la impresión al laboratorio (21);
- No se necesita la restauración provisional (21);
- Reduce los costes y los tiempos de trabajo (21).

Dentro las desventajas del CAD-CAM Chairside se encuentran (21):

- La necesidad de investigar más detalladamente sobre la adaptación marginal, fundamental para el éxito del tratamiento (21);
- No permite reproducir márgenes más pequeños que el diámetro de la fresa usada para fresar (21);
- Se necesita evitar hombros y ángulos netos para permitir el acceso de la fresa (21);
- La calidad de la imagen obtenida con el escáner intraoral depende del operador (21).

El disilicato de litio, más precisamente el e.max Press, y las cerámicas con leucita, además del método CAD-CAM, permiten también el método de inyección (15). El método de inyección consiste en un prensado isostático en caliente. Se inyecta una pastilla en un molde, con una técnica parecida a la de la cera perdida (15).

Además de los métodos anteriormente expuestos, caben destacar otras técnicas de fabricación (22):

- Técnica semidirecta extraoral. Consiste en tomar una impresión de alginato o de silicona de condensación, confeccionar un modelo de silicona de consistencia dura con doble viscosidad y en este modelo confeccionar la incrustación mediante el uso de composite y posteriormente cementar la restauración (22);

- Técnica semidirecta intraoral. Consiste en confeccionar la restauración directamente en boca con dique puesto, aislando el diente previamente con una capa de látex líquido aislante y sucesivamente se pone una matriz alrededor del diente y se añade el composite (22). Una vez que se haya confeccionado la restauración, se quita de la boca para los ajustes finales de los márgenes y de los puntos de contactos (22). La técnica semidirecta intraoral no se recomienda en cavidad mesio-distales profundas y presenta limitaciones debido a la dificultad de quitar de boca la restauración, por lo tanto se limita para la confección de onlay con 10 grados de divergencia como máximo (22);

- Técnica indirecta. Se produce en el laboratorio sobre un modelo de escayola (22).

## J. CEMENTACIÓN

En odontología existen dos tipos de cementos (4):

- Cementos convencionales. Presentan unión micromecánica;
- Cementos adhesivos a base de resina. Presentan unión micromecánica y química.

Las restauraciones indirectas parciales adhesivas necesitan un cementado de tipo adhesivo mediante cementos de resina (4) o mediante resina compuesta fotopolimerizable precalentada (23)(24)(25). El cemento a base de resina presenta como ventaja un módulo de elasticidad cuyo valor es parecido a lo de la dentina, por lo tanto la carga está repartida en manera más ecua sobre la interfase elástica (4). Para otro lado, son muy exigente a la técnica y no toleran contaminantes como por ejemplo presencia de humedad, eugenol, saliva, sangre y tejidos con caries (4).

Por otro lado, la resina compuesta fotopolimerizable permite controlar el tiempo de trabajo y remover los excesos de material (24). El nuevo protocolo de cementación, de acuerdo con los autores Dietschi e Spreafico, consiste en llevar a cabo las técnicas adhesivas con aislamiento absoluto, sellado inmediato de la dentina después de la preparación no retentiva, poner obligatoriamente una capa de composite fluido para cubrir la dentina, sellar los socavados y recolocar los márgenes subgingivales (si necesario)(17), usar un provisional fotopolimerizado sin cementarlo, emplear como agente cementante el composite precalentado fotopolimerizable e insertar la restauración con punta sónica o ultrasónica (24).

A continuación se enseña una tabla donde se resume el nuevo protocolo de cementación de las restauraciones indirectas adhesivas de clase II.

**Table 2** Description of the major differences between the conventional and the revised preparation and cementation protocols for indirect adhesive class II restorations (according to Dietschi and Spreafico, 1997 and 1998)

| Clinical steps | Conventional protocol | Revised protocol |
|---|---|---|
| Preparation | - No specific isolation<br>- Convenient marginal and internal design is required (taper) | - Under rubber dam, mostly under water spray<br>- Only marginal convenient design required |
| DBA application | At cementation | Just after preparation |
| Base/liner | Optional | Mandatory |
| Base/liner material | Composite or glass ionomer(s) | Composite only (flow mainly) |
| Provisional restoration | Cemented provisional temporary recommended | Non-cemented, light-curing temporary |
| Luting material | Dual-curing composite cement | Light-curing restorative composite |
| Restoration insertion | Manual | Assisted with sonic/ultrasonic tip (eventually with heated material) |

*Figura 10: Nuevo protocolo de cementación de las restauraciones indirectas adhesivas de clase II* (24). *Página 221.*

## 2. OBJETIVOS

Objetivo principal: Revisar/Valorar los distintos tipos de incrustaciones atendiendo al tipo de preparación y material.

Objetivos secundarios:

- Analizar las indicaciones de las incrustaciones valorando el tejido dental remanente;
- Analizar la longevidad /supervivencia en el tiempo de las incrustaciones;
- Comparar los distintos tipos de materiales para las incrustaciones atendiendo a sus indicaciones, ventajas e inconvenientes;
- Analizar los distintos tipos de preparaciones para las incrustaciones.

## 3. METODOLOGÍA

### A. Análisis de búsqueda de estudios y recogida de datos

Se realizó una búsqueda bibliográfica utilizando artículos de impacto de los últimos 5 años seleccionados en revistas de prestigio como por ejemplo "The Journal of Prosthetic Dentistry". Sin embargo, algunos artículos no respetan el rango cronológico, pero han sido incluidos debido a la información que aportaban, por lo tanto se decidió citar un artículo del año 2003 que trata de las indicaciones y contraindicaciones de las incrustaciones en general, sin basarse en los materiales. Se utilizó para la búsqueda bibliográfica Medline Complete y el sitio web de la biblioteca Crai.

Algunos artículos no ofrecían la oportunidad de descargar el texto completo, pero gracias a la ayuda de Biblioteca Crai, ha sido posible obtener el texto completo de dichos articulos.

Han sido de gran relevancia dos artículos propuestos por la Universidad Europea durante el curso de la asignatura de Prótesis Estomatológica III. Los artículos en cuestión son "Advancements in CAD/CAM technology" y "A New Classification System for All-Ceramic and Ceramic-like Restorative Materials" en particular este último ha sido muy útil a la hora de clasificar los materiales e indicar en manera sistemática el uso clínico.

Las palabras utilizadas para la búsqueda: incrustación, onlay, inlay, overlay, tipos de preparaciones, materiales cerámicos.

Words: inlay, onlay, inlay, overlay, types of preparations, ceramic materials.

## B. Criterios de inclusión y exclusión

No se han incluidos artículos que no aportaban resultados clínicos relevantes, que no tenían suficientes citas bibliográficas y que no respectaban el rango cronológico. Se ha intentado elegir meta análisis y revisión sistemática que aportan más evidencias científicas. Han sido incluidos 33 artículos.

# 4. DISCUSIÓN DE RESULTADOS

## A. Tipos de materiales

Mediante un estudio in vitro se quiere comparar la translucidez de la zirconia y la del disilicato de litio (26). Por lo tanto se estudian 5 tipos de zirconia y un tipo de disilicato de litio (26).

Se analizan como zirconias: Prettau Anterior, BruxZir, Katana HT, Katana ST y Katana UT y como disilicato de litio el IPS e.max CAD LT (26).

Las zirconias estudiadas presentan elevada translucidez con menor contenido en alúmina respecto y pertenecen al grupo de las zirconias estabilizada (26)(15). El IPS e.max CAD LT (low translucency) pertenece a las cerámicas con matrices vítreas sintéticas que derivan del disilicato de litio (15).

El estudio analiza un primer grupo cuyo espesor de materiales sea 0,5 mm y otro grupo cuyo espesor de 1 mm (26). Gracias a un espectrómetro se consiguen analizar los valores registrados entre los dos diferentes grupos (26). En el grupo de 0,5 mm de espesor, el material más translúcido se revela el disilicato de litio y, en el grupo de las zirconias, la más translúcida se demuestra la Katana UT (26). En el grupo de 1 mm de espesor el material

más translúcido se revela nuevamente el disilicato de litio, mientras que en el grupo de las zirconias, las más translúcidas son Prettau Anterior, Katana ST y Katana UT (26). Debido al alto grado de opacidad que presentan, BruxZir y Katana HT, pueden enmascarar un sustrato con un color desfavorable (26).

En general el material más translúcido, bien sea con espesor de 0,5 o bien sea de 1 mm, se demuestra el disilicato de litio (26). A continuación, se resume los resultados del estudio mediante una imagen.

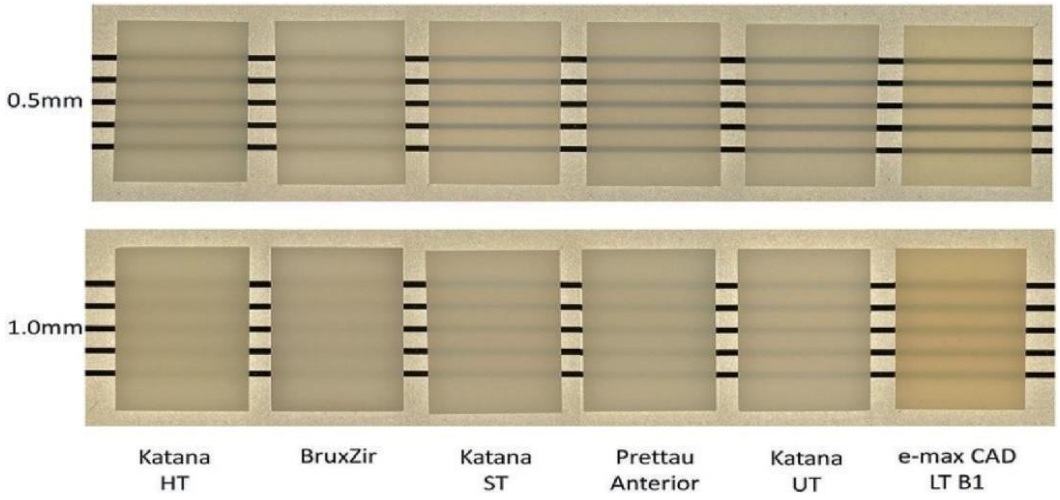



*Figura 11: Translucidez de los materiales estudiados con espesor de 0,5 mm y 1 mm (26). Página 260.*

Mediante otro estudio in vitro se quiere confrontar las propiedades mecánicas de la zirconia 5Y-ZP con la zirconia 3Y-TZP y el disilicato de litio (27).

Las zirconias comparadas pertenecen a la familia de zirconias policristalinas estabilizadas con itrio, la diferencia entre ambas consiste en la cantidad de moles con la cual se estabiliza, siendo la más utilizada la zirconia 3Y-TZP debido a la capacidad de frenar las grietas pero con la desventaja de presentar una elevada opacidad (27). Para solventar a este inconveniente, nace la zirconia 5Y-ZP con elevada resistencia y con una traslucidez parecida a la del disilicato de litio (27). La resistencia a la flexura es menor para el disilicato de litio y mayor

para la zirconia 3Y-TZP, la zirconia 5Y-ZP presenta una resistencia intermedia entre los dos materiales (27).

Teniendo en cuenta la traslucidez, apoyando los resultados del estudio precedente (26), el disilicato de litio presenta mayor traslucidez, sigue la zirconia 5Y-ZP y la zirconia 3Y-TZP (27).

Con el objetivo de investigar sobre el desgaste de los materiales protésicos, otro estudio in vitro compara cuatro materiales cerámicos con matriz de resina y un material cerámico (16). Entre el primer grupo destacan Vita Enamic, 3M Lava Ultimate, 3M Paradigm MZ100 y Kerr resina compuesta experimental (16). Vita Enamic se considera una cerámica vítrea infiltrada en una red polimérica de resina y Lava Ultimate se define como una resina nanocerámica (15). 3M Paradigm MZ100, se considera una cerámica zirconia-sílice en una red polimérica de resina (15). Kerr resina compuesta experimental está compuesta por composite nanohíbrido con refuerzo de fibra (16).

El material cerámico analizado es Vita Mark II y se trata de una cerámica feldespática (15). La pérdida vertical de sustancia después de 200.000 ciclos con el simulador contra el esmalte ha sido de 87,20 µm para Kerr resina compuesta experimental, 65,10 µm para 3M Paradigm, 61,90 µm para Lava Ultimate y Vita Enamic y 12,10 µm para Vita Mark II (16). A continuación, se resume los resultados del estudio mediante una tabla.

Table 2. Vertical substance loss after 200 000 cycles of test materials (µm)

| Material | Wear Value (mean ±SD) |
|---|---|
| 3M Lava Ultimate | 61.90 ±35.070* |
| Kerr experimental material | 87.20 ±35.036* |
| Vita Enamic | 61.90 ±39.549* |
| 3M Paradigm | 65.10 ±32.130* |
| Vita Mark II | 12.10 ±8.530 |

*Values did not exhibit significant differences (*P*>.05).

Figura 12. Desgaste de los materiales después de 200.000 ciclos con el simulador contra el esmalte. (16). *Página* 200.

Para averiguar el desgaste del esmalte antagonista debido a la presencia de los materiales protésicos se lleva a cabo un estudio in vitro donde se comparan LAVA Plus Zirconia, IPS e.max Press, Noritake Súper Porcelain EX-3, IPS e.max CAD y un grupo control con el esmalte natural (28).

IPS e.max Press e IPS e.max CAD se engloban al grupo de las cerámicas sintéticas a base de disilicato de litio (15). Noritake Super Porcelain EX-3 pertenece al grupo de las cerámicas sintéticas a base de leucita (15). LAVA Plus Zirconia se incluye en el grupo de las zirconias estabilizadas (15).

Los resultados del estudio evidencian que hay el mismo desgaste entre esmalte contra esmalte y esmalte contra materiales protésico (28). A diferencia de los resultados obtenidos in vitro, en vivo hay evidencia que los materiales protésicos analizados pueden desgastar el esmalte antagonista (28).

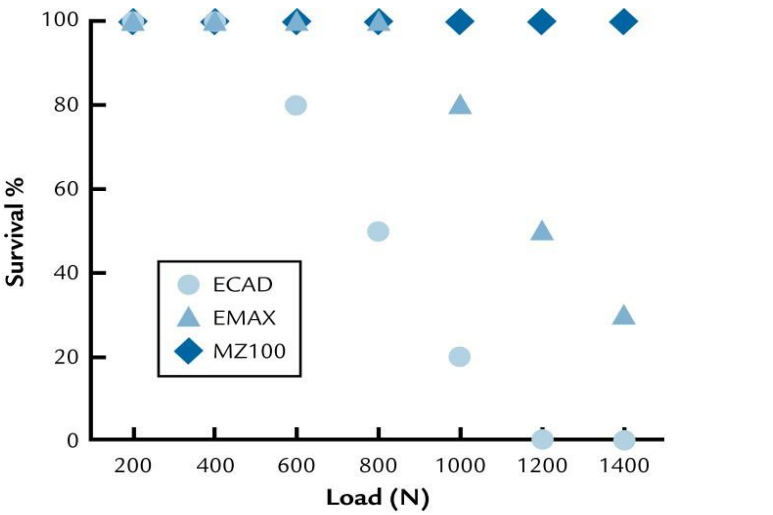
**B. Resistencia de los materiales**

El estudio in vitro realizado tiene como objetivo comparar la resistencia a la fatiga que proporciona la técnica directa mediante el uso de composite y la de técnica indirecta mediante el uso de inlays, en específico se compara el composite Miris 2 y el material Paradigm MZ100 fresado con el sistema CEREC (29). Miris 2 pertenece al grupo de composites nanohídridos heterogéneos (22), mientras que el material Paradigm MZ100 al grupo de las cerámicas con matriz de resina y en particular a las cerámicas zirconia-sílice en una red polimérica de resina (15). Por lo tanto se prepara una cavidad mesio-ocluso-distal y hay dos grupos de estudio: se analizan 15 terceros molares superiores donde se realiza una técnica directa y 17 terceros molares superiores donde se realizan inlays (29).

Ambos materiales están sometidos a un ciclo isométrico a 5 Hz a partir de 200 N hasta llegar a 1400 N, por lo tanto el grupo de composite, se fractura a 1213 N, de los cuales el 67% puede restaurarse y presenta una tasa de fractura del 13 % (29). El grupo de la cerámica con matriz de resina presenta una tasa de supervivencia del 100% (29). En el estudio in vitro llevado a cabo por P. Magne et all, se quiere comprar la resistencia a la fatiga de algunos materiales para realizar carillas oclusales posteriores (1).

Los materiales analizados son los siguientes: IPS Empress CAD, IPS e.max CAD, Paradigm MZ100 y todos son materiales que necesitan un sistema CAD/CAM (1).
El material IPS Empress CAD pertenece al grupo de las cerámicas vítreas sintéticas a base de leucita (1), el IPS e.max CAD pertenece a las cerámicas con matrices vítreas sintéticas que derivan del disilicato de litio y el material Paradigm MZ100, como ya dicho anterioramentee, pertenece al grupo de las cerámicas con matriz di resina y en particular a las cerámicas zirconia-sílice en una red polimérica de resina (15).

La muestra se compone de 30 molares donde se realiza una preparación cuyo espesor oclusal es de 1,2 mm (1). Como el estudio anterior, todos los materiales vienen sometidos a un ciclo isométrico a 5 Hz desde 200 hasta 1400 N (1). Después de los ciclos, el material más frágil es el IPS Empress CAD, sigue el IPS e.max CAD que presenta una tasa de supervivencia del 30% (1). El material más resistente es el Paradigm MZ100 que presenta una tasa de supervivencia del 100 % (1). También en el estudio anterior, se llega a la misma conclusión (29). A continuación, se resume los resultados del estudio.



4 Life table survival distributions by materials at each load step (n=10).

*Figura 13. Supervivencia de los materiales durante los diferentes ciclos isométricos (1). Página 154.*

A pesar de los resultados obtenidos, ninguna muestra presenta fracasos importantes, solamente se aprecian grietas en el material de restauración (1).

## C. Método de fabricación y tipos de impresiones

El estudio in vitro llevado a cabo, tiene como objetivo averiguar la precisión dimensional de las restauraciones indirectas tipo onlay fabricadas con e.max Press, usando varios métodos de fabricación (30). Por lo tanto se divide la muestra en 3 grupos (30). En el primer grupo se realiza impresión convencional y fabricación convencional de onlay en resina gracias a un modelo de escayola (30). En el segundo grupo se lleva a cabo una impresión convencional, se vacía el modelo en escayola y luego se escanea con un escáner extraoral de laboratorio el modelo para luego imprimirlo mediante una impresora 3D (30). En el último grupo se realiza un escaneado intraoral con TRIOS 3IOS 3Shape y luego se imprime el modelo en 3D (30). En los tres grupos se encuentra discrepancia en área pulpar y lingual, contrariamente al

margen bucal y lingual (30). El rango aceptable de discrepancia se encuentra entre 20-150 µm, por lo tanto los tres métodos presentan valores admisibles (30).

La discrepancia absoluta entre los tres grupos respectivamente tiene los siguientes valores: 82.6 µm, 113.4 µm y 104 µm (30). El método que presenta menor discrepancia es el método convencional (30). La diferencia de valores entre el grupo 1 y 2 se debe al uso de la impresora 3D, responsable de crear onlays de calidad más baja, y no al uso de una técnica de impresión digital o convencional, de hecho no hay diferencia significativa entre el uso de una de las dos técnicas (30).

Mediante un estudio in vitro, se quiere averiguar la adaptación interna y la precisión del ajuste marginal del encerado diagnóstico de las restauraciones parciales indirectas adhesivas fabricadas con el disilicato de litio (IPS e.max Press) mediante varios métodos (31). Por lo tanto, se crean 5 grupos de 15 muestras cada uno (31). Los primeros tres grupos reciben impresión de tipo convencional, mientras que los otros dos, una impresión de tipo digital (31). El primer grupo recibe una impresión convencional con polivinilo siloxano y se encera el modelo manualmente (31).

En el segundo grupo se realiza, como antes una impresión convencional con el mismo material, pero a continuación se escanea el modelo de escayola con un escáner extraoral del laboratorio y se lleva a cabo el encerado diagnóstico digital mediante fresado (31).

El tercer grupo recibe los mismos tratamientos del grupo anterior con la diferencia que en lugar de llevar a cabo el encerado con el método de fresado, se realiza la impresión del encerado diagnóstico con impresora en 3D (31). El cuarto grupo recibe un escaneado intraoral y a continuación se lleva a cabo un encerado diagnóstico digital mediante fresado (31). El último grupo, igual que el cuarto, recibe un escaneado intraoral digital y luego se realiza la impresión del encerado diagnóstico con impresora en 3D (31).

A continuación, en todos los grupos se realiza la restauración final tipo inlays usando IPS e.max Press (31). El cuarto grupo presenta los valores de discrepancia marginal más bajos (24.3 µm), mientras que el primer grupo presenta los valores más elevados (45.1 µm) (31). En el estudio in vitro precedente, el método convencional presentaba los valores de discrepancia marginales más bajos (30). Además el estudio evidencia que el encerado diagnóstico llevado a cabo con una impresora 3D presenta los mismos ajustes y adaptación respecto a la técnica convencional (31).

El artículo precedente (30), considera la impresora 3D responsable de fabricar onlay de calidad más baja.

## D. Tipos de preparaciones

Según el artículo de Ferraris, el butt joint constituye el tipo de preparación de elección y su variante, el bisel, en algunos casos (12). Se aconseja el butt joint debido a la preparación mínima que requiere, facilitando la técnica adhesiva (12). Por otra parte, según Veneziani, el butt joint está indicado en la caja interproximal con un espesor de 1 mm hasta 1,2 mm, y se recomienda en las paredes linguales de los molares y premolares inferiores debido a la anatomía que presentan (3).

El espesor tiene que ser reducido para aportar resistencia y averiguar una correcta polimerización del cemento (3). Según el autor Veneziani, el bisel cóncavo (hollow chamfer) permite la máxima preservación de la estructura dental remanente, es más favorable para la técnica adhesiva y se utiliza sobre todo en las paredes vestibular y palatina de los premolares y molares superiores y para las paredes vestibulares de los molares y premolares inferiores (3). Se usa el hollow chamfer en el caso de que las paredes axiales

sean coronales respecto al ecuador dental (3). En el caso de que las paredes axiales sean apicales respecto a la línea de máximo contorno, se recomienda el butt joint (3).

Según Magne, el bisel cóncavo se puede obtener mediante una fresa redonda y asegura óptima adaptación marginal y estética (7). Según el artículo de Ferraris el bisel está indicado en los casos donde se necesita estética, mayor espacio oclusal y mayor superficie de esmalte para mejorar las técnicas de adhesión (12). A diferencia de Veneziani que no recomienda una preparación en hombro debido a que es poco conservador y no compatible con las técnicas adhesivas (3), según Ferraris en los casos de previa fractura cuspídea o en presencia de abfracciones y necesidad de mayor protección, el tipo de preparación más adecuado será el hombro redondeado de 1 mm (12).

## E. Protocolo de cementación

La presencia de un margen subgingival presenta un reto para el odontólogo a la hora de llevar a cabo las técnicas adhesivas, tomar las impresiones y cementar la restauración (8).

Ambos artículos (23)(24) concuerdan sobre los principios expuestos en el protocolo de cementación llevado a cabo de Dietschi y Spreafico en el 1998.

El protocolo consta de 4 puntos fundamentales (24):

- Sellado inmediato de la dentina;
- Optimización del diseño de la cavidad;
- Elevación de los márgenes subgingivales;
- Cementación adhesiva controlada.

El sellado inmediato de la dentina se lleva a cabo antes de la toma de las impresiones y antes de poner el provisional y tiene como objetivo aumentar la fuerza del enlace y la calidad de la interfase adhesiva (24).

La optimización del diseño de la cavidad tiene como objetivo rellenar los socavados y dar armonía a la geometría de la cavidad y el material de elección es el composite fluido (24). Otro artículo evidencia que también se puede usar ionómero de vidrio a base de resina (7). La elevación de los márgenes subgingivales tiene como objetivo elevar los márgenes hasta conseguir márgenes supra gingivales que facilitan la toma de las impresiones, las técnicas adhesivas y la cementación (24). Según el autor Veneziani, para realizar la elevación de los márgenes subgingivales, el material de elección es una capa de 1 mm de composite fluido (8). Según los autores Dietschi y Spreafico para llevar a cabo la elevación de los márgenes subgingivales se puede usar el composite fluido hasta 1-1,5 mm y en el caso de que se necesite más material, se puede elegir un composite fluido con mucho relleno o una resina fluida indicada para la técnica bulk fill (24). Los autores Magne y Spreafico concuerdan sobre la necesidad de una matriz especial curva modificada diferente respecto a la clásica (23). Los artículos (17)(23)(24)(25) indican las resinas compuestas con relleno fotopolimerizable aptas como agente cementante para las restauraciones indirectas y se prefieren respecto a las duales porque presentan características mecánicas mejores, resistencia al desgaste mayor respecto a los cementos de resina a base de metacrilato o bifosfonato, fácil uso, permiten controlar el tiempo de trabajo y controlar y remover los excesos de materiales (17)(23)(24)(25). Las resinas compuestas presentan mejores propiedades si se precalientan, además si se aumenta la temperatura disminuye la viscosidad y el riesgo de ajuste incompleto (25).

## F. Supervivencia en el tiempo

El estudio clínico realizado tiene como objetivo comparar la supervivencia de las restauraciones parciales indirectas adhesivas realizadas con disilicato de litio y más precisamente con IPS e.max Press (32). El protocolo llevado a cabo consta de grabado ácido al 4,5 % con ácido hidrofluorhídrico para 20 segundos y aplicación de silano durante 1 minuto en la restauración y de ácido ortofosfórico al 38% y adhesivo en el diente (32). El análisis realizado evidencia que sobre 610 restauraciones parciales indirectas adhesivas, solo 6 muestran fracasos y que presentan una tasa de supervivencia a los 10.5 años de 95.27% (32). Se considera un fracaso la sustitución de la restauración (32). El estudio no evidencia diferencias entre tipo de restauración, arcada dental, posición del diente en arcada, edad, sexo y espesor de la cerámica (32). El estudio retrospectivo realizado evalúa la tasa de fracaso de las restauraciones indirectas adhesivas realizada con disilicato de litio monolítico (IPS e.max) durante un rango de tiempo de 45 meses (19). Sobre 1093 entre inlay y onlay, solo 11 restauraciones han demostrado un fracaso (19).

Igual que en el estudio clínico anterior (32), se considera un fracaso la sustitución de la restauración (19).

Por lo tanto la tasa de fracaso es igual a 1.01% y por lo tanto la tasa de suceso es del 98.99 % (19).

El último articuló de la tríada “Evidence-based concepts and procedures for bonded inlays and onlays”, tiene como objetivos enseñar el follow-up en un rango de 6 hasta 21 años, de 25 casos clínicos entre inlays y onlays realizados en composite con técnica indirecta o semidirecta (intraoral o extraoral) y habiendo llevado a cabo el nuevo protocolo de cementación de las restauraciones indirectas adhesivas explicado en las dos partes anteriores (22). Las restauraciones han sido realizadas con composites microhíbridos (Tetric,

Belleglass, Miris y TPH) y nanohíbrido heterogéneo (Miris 2) (22). El estudio clínico retrospectivo evidencia que ninguna restauración ha sufrido algún tipo de fractura y tampoco la necesidad de un tratamiento de conductos (22).

Sobre 25 restauraciones, 16 se realizan con composite microhíbrido (5 con Tetric, 4 con Belleglass, 6 con Miris y 1 con TPH) y las restantes 9 todas con composites nanohíbrido Miris 2 (22).

El método de evaluación llevado a cabo es parecido al método USPHS (22), que viene usado el siguiente estudio retrospectivo sobre el cual se hablará a continuación.

Los parámetros evaluados engloban la calidad de los márgenes, la anatomía y el color (22). Cada uno se evalúa mediante A-B-C (22). Ninguna restauración presenta un valor C (22).

Del grupo de los composites microhíbridos solo 2 presentan margen con decoloración, mientras que en el grupo de los composites nanohíbridos 4 presentan márgenes con decoloración y degradación y 6 cambios discretos en la anatomía (22).

El composite nanohíbrido heterogéneo Miris 2 presenta peores comportamientos clínicos respecto a los composites microhíbridos debido probablemente a la presencia de nanocluster, en todo caso se necesitan más datos clínicos para poder afirmarlo (22).

Otro estudio retrospectivo llevado a cabo, igualmente tiene como objetivo evaluar los resultados clínicos de 31 premolares y 158 molares, ambos endodonciados, que hayan sido restaurados mediante onlay de composite durante un rango de tiempo que va desde 24 hasta 52 meses y con revisiones periódicas cada 6 meses (33).

De acuerdo con los criterios modificados USPHS, todas las restauraciones tienen A como valor para los parámetros de decoloración marginal oclusal, estructura de la anatomía interproximal, caries secundarias y fractura marginal (33). Sobre 189 restauraciones, teniendo en cuenta el valor B, 29 presentan coincidencia de color, 5 adaptación marginal

oclusal, 5 adaptación marginal interproximal, 15 decoloración marginal interproximal, 17 estructura de la anatomía oclusal y 2 fractura del cuerpo (33). Sobre 189 restauraciones, teniendo en cuenta el valor C, 4 presentan retención y 3 coincidencia del color (33). Los datos anteriormente mencionados se ilustran en la siguiente tabla.

**Table 3** Evaluation of the onlay restorations ($N = 189$) according to modified USPHS criteria

| | Criteria rating (*n*) | | |
|---|---|---|---|
| Modified USPHS criteria | A | B | C |
| Retention | 185 (97.9%) | 0 | 4 (2.1%) |
| Colour match | 157 (83.1%) | 29 (15.3%) | 3 (1.6%) |
| Occlusal marginal adaptation | 184 (97.4%) | 5 (2.6%) | 0 |
| Interproximal marginal adaptation | 184 (97.4%) | 5 (2.6%) | 0 |
| Occlusal Marginal discoloration | 189 (100%) | 0 | 0 |
| Interproximal marginal discoloration | 174 (92.1%) | 15 (7.9%) | 0 |
| Interproximal anatomical structure | 189 (100%) | 0 | 0 |
| Occlusal anatomical structure | 172 (91%) | 17 (9%) | 0 |
| Secondary caries at the occlusal surface | 189 (100%) | 0 | – |
| Secondary caries at the interproximal surfaces | 189 (100%) | 0 | – |
| Marginal fracture | 189 (100%) | 0 | – |
| Body fracture | 187 (99%) | 2 (1%) | |

*Figura 14: Evaluación de las restauraciones tipo onlay (N=189) según los criterios modificado USPHS* (33). *Página 971.*

Por lo general, cada resultado se clasifica en supervivencia, supervivencia funcional y fracaso absoluto de la restauración (33). Se define supervivencia la ausencia de fracaso y la presencia de retención (33). Se considera supervivencia funcional la falta de retención (33). Se trata de fracaso absoluto si la restauración necesita reemplazo (33). La supervivencia de la restauración fue del 96,8% y la supervivencia funcional fue del 98,9% (33).

## 5. CONCLUSIONES

- Según la literatura, atendiendo al tipo de preparación y al material, existen distintos tipos de incrustaciones entre las cuales cabe destacar las incrustaciones tipo inlay, onlay, endocrown, overlay, overlay adicional, carillas oclusales, veneerlay y long wrap overlay.

- El disilicato de litio e.max Press representa una válida opción como material para las restauraciones indirectas adhesivas y demuestra excelente supervivencia. Las incrustaciones de composite presentan elevada tasa de éxito y se pueden considerar una opción efectiva para dientes posteriores endodonciados.

- Ateniendo a la cantidad de tejido dental remanente, en diente posterior endodonciado, la presencia de una cresta marginal de espesor mayor a 2,5 mm presupone una incrustación tipo inlay, si el espesor de las cúspides adyacentes a la cresta marginal comprometida fuese menor de 2,5 mm se opta para una incrustación tipo onlay, y si el diente presentase fisuras o fuese una cavidad del tipo mesio-ocluso-distal, el tratamiento de elección es una incrustación tipo overlay. Por lo tanto, las incrustaciones onlay u overlay representan el tratamiento de elección para los dientes posteriores endodonciados que presentan una importante pérdida de sustancia, pero que conservan una cantidad adecuada de esmalte cervical.

- Entre los materiales utilizados para las incrustaciones se encuentran las cerámicas con matriz vítrea, las policristalinas y las que contienen matriz de resina. El disilicato di litio presenta mayor traslucidez respecto a la zirconia pero menor resistencia a la flexura. Los materiales cerámicos con matriz de resina (Lava Ultimate y Vita Enamic) presentan mayor desgaste si se comparan con materiales cerámicos (Vita Mark II) pero facilitan las reparaciones y presentan un módulo de Young parecido a lo de la dentina.

- Se diferencian cuatro tipos de preparación: butt joint, bisel, hombro y bisel cóncavo . Según Ferraris el butt joint constituye el tipo de preparación de elección y su variante, el bisel, en algunos casos. Se aconseja el butt joint debido a la preparación mínima que necesita, facilitando la técnica adhesiva (9). Según el autor Veneziani, el bisel cóncavo (hollow chamfer) permite la máxima preservación de la estructura dental remanente y es más favorable para la técnica adhesiva.

## 7. RESPONSABILIDAD SOCIAL

Gracias a los nuevos métodos de fabricación de las incrustaciones y de las restauraciones indirectas en general, disminuye la contaminación ambiental y se reducen los materiales de desecho producidos por la técnica convencional. Por otra parte, la toma de impresión digital con el escáner intraoral ha sustituido, en la mayoría de los casos, la técnica tradicional y por lo tanto ha limitado los residuos derivados de los materiales de impresiones. Como consecuencia, el escáner intraoral y los nuevos métodos de fabricación (fresado y sinterizado) reducen el impacto sobre el medio ambiente respecto a las técnicas tradicionales.

## 6. BIBLIOGRAFÍA


1. Magne P, Schlichting LH, Maia HP, Baratieri LN. In vitro fatigue resistance of CAD/CAM composite resin and ceramic posterior occlusal veneers. J Prosthet Dent [Internet]. 2010;104(3):149–57. Available from: http://dx.doi.org/10.1016/S0022-3913(10)60111-4

2. Polesel A. Gli intarsi adesivi per il restauro dei denti posteriori trattati endodonticamente. G Ital Endod [Internet]. 2012;26(2):40–51. Available from: http://dx.doi.org/10.1016/j.gien.2012.05.001

3. Veneziani M. Posterior indirect adhesive restorations: updated indications and the Morphology Driven Preparation Technique. Int J Esthet Dent. 2017;12(2):204–30.

4. Pradella S. Restauri indiretti nei settori posteriori. Il dentista moderno. 2012;32–62.

5. Polesel A. Il restauro conservativo del dente singolo posteriore trattato endodonticamente. G Ital Endod [Internet]. 2011;25(1):3–21. Available from: http://dx.doi.org/10.1016/j.gien.2011.05.006

6. de Carvalho MA, Lazari PC, Gresnigt M, Del Bel Cury AA, Magne P. Current options concerning the endodontically-treated teeth restoration with the adhesive approach. Braz Oral Res. 2018;32(October):147–58.

7. Magne P. Composite resins and bonded porcelain: the postamalgam era? J Calif Dent Assoc. 2006;34(2):135–47.

8. Veneziani M. Restauri adesivi dei settori posteriori con margini cervicali subgengivali: nuova classificazione e approccio. Dent Mod [Internet]. 2008;5(1):1–25.

9. Tribst JPM, Dal Piva AM de O, Madruga CFL, Valera MC, Borges ALS, Bresciani E, et al. Endocrown restorations: Influence of dental remnant and restorative material on stress distribution. Dent Mater [Internet]. 2018;34(10):1466–73. Available from: https://doi.org/10.1016/j.dental.2018.06.012

10. Al-Dabbagh RA. Survival and success of endocrowns: A systematic review and meta-analysis. J Prosthet Dent [Internet]. 2020;1–9. Available from: https://doi.org/10.1016/j.prosdent.2020.01.011

11. Opdam NJM, Frankenberger R, Magne P. From "direct versus indirect" toward an integrated restorative concept in the posterior dentition. Oper Dent. 2016;41:S27– 34.

12. Ferraris F. Posterior indirect adhesive restorations (PIAR): preparation designs and adhesthetics clinical protocol. Int J Esthet Dent. 2017;12(4):482–502.

13. Vailati F, Belser UC. Full-mouth adhesive rehabilitation of a severely eroded dentition: the three-step technique. Part 2. Eur J Esthet Dent. 2008;3(2):128–46.

14. Meyer A, Cardoso LC, Araujo E, Baratieri LN. Ceramic inlays and onlays: clinical procedures for predictable results. J Esthet Restor Dent. 2003;15(6):338–52.

15. Gracis S, Thompson V, Ferencz J, Silva N, Bonfante E. A New Classification System for All-Ceramic and Ceramic-like Restorative Materials. Int J Prosthodont.2016;28(3):227-35.

16. Zhi L, Bortolotto T, Krejci I. Comparative in vitro wear resistance of CAD/CAM composite resin and ceramic materials. J Prosthet Dent [Internet]. 2016;115(2):199–202. Available from: http://dx.doi.org/10.1016/j.prosdent.2015.07.011

17. Rocca GT, Rizcalla N, Krejci I, Dietschi D. Evidence-based concepts and procedures for bonded inlays and onlays. Part II. Guidelines for cavity preparation and restoration fabrication. Int J Esthet Dent. 2015;10(3):392–413.

18. Dejak B, Młotkowski A. A comparison of mvM stress of inlays, onlays and endocrowns made from various materials and their bonding with molars in a computer simulation of mastication – FEA. Dent Mater [Internet]. 2020;36(7):854–64. Available from: https://doi.org/10.1016/j.dental.2020.04.007

19. Sulaiman TA, Delgado AJ, Donovan TE. Survival rate of lithium disilicate restorations at 4 years: A retrospective study. J Prosthet Dent [Internet]. 2015;114(3):364–6. Available from: http://dx.doi.org/10.1016/j.prosdent.2015.04.011

20. Alghazzawi TF. Advancements in CAD/CAM technology: Options for practical implementation. J Prosthodont Res [Internet]. 2016;60(2):72–84. Available from: http://dx.doi.org/10.1016/j.jpor.2016.01.003

21. Lima FF, Neto CF, Rubo JH, Santos GC, Moraes Coelho Santos MJ. Marginal adaptation of CAD-CAM onlays: Influence of preparation design and impression technique. J Prosthet Dent[Internet].2018;120(3):396–402.
Available from: https://doi.org/10.1016/j.prosdent.2017.10.010

22. Dietschi D, Spreafico RC. Evidence-based concepts and procedures for bonded inlays and onlays. Part III. A case series with long-term clinical results and follow- up. Int J Esthet Dent. 2019;14(2):118–33.

23. Magne P, Spreafico RC. Deep Margin Elevation: A Paradigm Shift. Quintessence 2012; 2 (2): 86-96.

24. Dietschi D, Spreafico RC. Evidence-based concepts and procedures for bonded inlays and onlays. Part I. Historical perspectives and clinical rationale for a biosubstitutive approach. Int J Esthet Dent [Internet].2015;10(2):210-27. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84953342603&partnerID=40&md5=56706bfdaffc714b8ac7e934dd3cbe8b

25. Magne P, Razaghy M, Carvalho MA, Soares LM. Luting of inlays, onlays and overlays with preheated restorative composite resin does not prevent seating accuracy. Int J Esthet Dent. 2018;13(3):318–32.

26. Harada K, Raigrodski AJ, Chung KH, Flinn BD, Dogan S, Mancl LA. A comparative evaluation of the translucency of zirconias and lithium disilicate for monolithic restorations. J Prosthet Dent [Internet]. 2016;116(2):257–63. Available from: http://dx.doi.org/10.1016/j.prosdent.2015.11.019

27. Kwon SJ, Lawson NC, McLaren EE, Nejat AH, Burgess JO. Comparison of the mechanical properties of translucent zirconia and lithium disilicate. J Prosthet Dent [Internet].2018;120(1):132-7.
Available from : https://doi.org/10.1016/j.prosdent.2017.08.004

28. Zandparsa R, El Huni RM, Hirayama H, Johnson MI. Effect of different dental ceramic systems on the wear of human enamel: An in vitro study. J Prosthet Dent [Internet]. 2016;115(2):230–7. Available from: http://dx.doi.org/10.1016/j.prosdent.2015.09.005

29. Batalha-Silva S, De Andrada MAC, Maia HP, Magne P. Fatigue resistance and crack propensity of large MOD composite resin restorations: Direct versus CAD/CAM inlays. Dent Mater [Internet]. 2013;29(3):324–31. Available from: http://dx.doi.org/10.1016/j.dental.2012.11.013

30. Eftekhar Ashtiani R, Nasiri Khanlar L, Mahshid M, Moshaverinia A. Comparison of dimensional accuracy of conventionally and digitally manufactured intracoronal restorations. J Prosthet Dent [Internet]. 2018;119(2):233–8. Available from: https://doi.org/10.1016/j.prosdent.2017.03.014

31. Homsy FR, Özcan M, Khoury M, Majzoub ZAK. Marginal and internal fit of pressed lithium disilicate inlays fabricated with milling, 3D printing, and conventional technologies. J Prosthet Dent [Internet]. 2018;119(5):783–90. Available from: https://doi.org/10.1016/j.prosdent.2017.07.025

32. Malament KA, Margvelashvili-Malament M, Natto ZS, Thompson V, Rekow D, Att W. Comparison of 16.9-year survival of pressed acid etched e.max lithium disilicate glass ceramic complete and partial coverage restorations in posterior teeth: Performance and outcomes as a function of tooth position, age, sex, and thickness of ceramic material. J Prosthet Dent[Internet]. 2020;1–13. Available from: https://doi.org/10.1016/j.prosdent.2020.08.013

33. Chrepa V, Konstantinidis I, Kotsakis GA, Mitsias ME. The survival of indirect composite resin onlays for the restoration of root filled teeth: A retrospective medium-termstudy. Int Endod J. 2014;47(10):967–73.

# 8. ANEXOS

## In vitro fatigue resistance of CAD/CAM composite resin and ceramic posterior occlusal veneers

**Pascal Magne, DMD, PhD,[a] Luís Henrique Schlichting, DDS, MS,[b] Hamilton Pires Maia, DDS, PhD,[c] and Luiz Narciso Baratieri, DDS, PhD[d]**

University of Southern California, Herman Ostrow School of Dentistry of USC, Los Angeles, Calif; Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil

**Statement of problem.** Thin, bonded, posterior occlusal veneers constitute a conservative alternative to traditional complete coverage crowns. Information regarding selection of the appropriate material and its influence on fatigue resistance, which may affect the longevity of the restoration, is missing.

**Purpose.** The purpose of this study was to assess and compare the fatigue resistance of composite resin and ceramic posterior occlusal veneers.

**Material and methods.** Thirty extracted molars received a standardized nonretentive tooth preparation (simulating advanced occlusal erosion), including removal of occlusal enamel, exposure of dentin, and immediate dentin sealing (Optibond FL). All teeth were restored with a 1.2-mm-thick occlusal veneer (Cerec 3 chairside CAD/CAM system). The restorations (n=10) were milled from leucite-reinforced and lithium disilicate ceramics (IPS Empress CAD and IPS e.max CAD, respectively) and a composite resin (Paradigm MZ100). The intaglio surfaces of the ceramic restorations were conditioned by hydrofluoric acid etching and silane. Airborne-particle abrasion and silane were used to condition the composite resin restorations. Preparations were airborne-particle abraded and etched. All restorations were bonded with preheated luting material and submitted to cyclic isometric loading at 5 Hz, starting with a load of 200 N (x5000 cycles), followed by stepwise loading of 400, 600, 800, 1000, 1200, and 1400 N at a maximum of 30,000 cycles each. The number of cycles at initial failure (first cracks) was recorded. Specimens were loaded for a maximum of 185,000 cycles. Groups were compared using the life table survival analysis ($\alpha$=.016, Bonferroni method).

**Results.** IPS Empress CAD failed at an average load of 900 N, with no specimen withstanding all 185,000 load cycles (survival 0%), while IPS e.max CAD and Paradigm MZ100 demonstrated survival rates of 30% and 100%, respectively. None of the specimens exhibited catastrophic failure, but only cracks limited to the restorative material.

**Conclusions.** Posterior occlusal veneers made of composite resin (Paradigm MZ100) had significantly higher fatigue resistance ($P$<.002) compared to IPS Empress CAD and IPS e.max CAD. (J Prosthet Dent 2010;104:149-157)

The second author was supported by the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES) (grant no. BEX 1689/08-8).

Based on a thesis submitted to the Dentistry Graduate Program, Federal University of Santa Catarina, in partial fulfillment of the requirements for the PhD degree of Luís Henrique Schlichting.

[a]Associate Professor of Dentistry, University of Southern California, Herman Ostrow School of Dentistry of USC; The Don and Sybil Harrington Foundation Chair of Esthetic Dentistry.
[b]Assistant Professor, Division of Restorative Sciences, University of Southern California, Herman Ostrow School of Dentistry of USC; PhD student, Department of Operative Dentistry, Federal University of Santa Catarina.
[c]Associate Professor, Department of Operative Dentistry, Federal University of Santa Catarina.
[d]Professor and Chair, Department of Operative Dentistry, Federal University of Santa Catarina.



Giornale Italiano di Endodonzia (2012) 26, 40–51

Disponibile online all'indirizzo www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/gie

FOCUS

# Gli intarsi adesivi per il restauro dei denti posteriori trattati endodonticamente

## *The restoration of posterior endodontically treated teeth: bonded inlays*

Andrea Polesel*

*Libero Professionista in Arenzano*

Ricevuto il 29 aprile 2012; accettato l'8 maggio 2012
Disponibile online il 7 giugno 2012

**PAROLE CHIAVE**
Resine composite;
Restauri;
Intarsi;
Dente trattato endodonticamente;
Dente posteriore.

**KEY WORDS**
Composite resins;
Restorations;
Inlays;
Endodontically treated tooth;
Posterior tooth.

**Riassunto**
*Obiettivi:* Scopo del lavoro è valutare, attraverso l'analisi della letteratura e la presentazione di una serie di casi, le applicazioni cliniche degli intarsi adesivi per il restauro dei denti singoli posteriori trattati endodonticamente.
*Materiali e metodi:* I cambiamenti biomeccanici secondari al trattamento o al ritrattamento endodontico e la perdita di sostanza dentale sana indotta da patologie o fattori iatrogeni indirizzano il clinico verso un restauro che sigilli, protegga e rinforzi l'elemento naturale. La corona completa è il "gold standard" e trova indicazione in elementi gravemente compromessi. In elementi mediamente compromessi, le applicazioni cliniche offerte dalle tecniche adesive, attraverso i restauri conservativi, consentono oggi di preservare maggiore sostanza dentale sana e rimandare nel tempo il restauro protesico.
*Risultati e conclusioni:* I restauri indiretti adesivi rappresentano un'opzione terapeutica conservativa per il restauro del dente singolo posteriore trattato endodonticamente.


**Summary**
*Objectives:* To analyse, through a literature review and clinical cases presentation, the factors leading the clinician in the choice of bonded inlays for the restoration of single posterior endodontically treated teeth.
*Materials and methods:* Biomechanical changes due to the endodontic treatment or retreatment and the loss of healthy dental tissue caused by pathological and iatrogenic factors lead the clinician to a restoration that can to seal, reinforce, and protect the tooth. The full crown is considered the gold standard by the literature; it is indicated in case of teeth heavily weakened by pathology or previous prosthetic preparations. In medium-sized cavity, conservative bonded

* Piazza Golgi 16/1 – 16011 Arenzano (GE).
*E-mail:* andrea.polesel@libero.it.

1121-4171/$ – see front matter © 2012 Società Italiana di Endodonzia. Pubblicato da Elsevier Srl. Tutti i diritti riservati.
doi:10.1016/j.gien.2012.05.001

# Posterior indirect adhesive restorations: updated indications and the Morphology Driven Preparation Technique

**Marco Veneziani,** DDS
Private practice, Vigolzone (PC), Italy
Visiting Professor, University of Pavia, 2007–2012
Active member, Accademia Italiana di Conservativa
Active member, Italian Academy of Esthetic Dentistry
Active member, International Academy for Digital Dental Medicine

Correspondence to: Dr Marco Veneziani
Via Roma 57, 29020 Vigolzone (PC), Italy; Tel/fax: +39 0523 870362; Mobile: +39 3351 435187;
Email: marco.veneziani@hesh.biz; veneziani.mar@gmail.com

# Restauri indiretti nei settori posteriori

• Sandro Pradella

La ricostruzione degli elementi dentali – affetti da processi cariosi primari o secondari – nei settori posteriori è sempre oggetto di riflessioni da parte del clinico; infatti, quando si affrontano casi di questo tipo, la decisione se usare una tecnica diretta o indiretta deve tenere conto di alcuni parametri fondamentali che possono far propendere per una tecnica o per un'altra.
Qualora si scelga la tecnica indiretta, esistono alcuni punti saldi che bisogna considerare per ottenere un risultato finale ottimale; l'insieme di questi passaggi è contenuto nella tabella 1.

## Scelta tra tecnica diretta vs tecnica indiretta

Valutando la letteratura in proposito, il primo criterio che viene valutato nella scelta tra restaurare una cavità con tecnica diretta o con tecnica indiretta è l'ampiezza della cavità[1]. Inoltre a sfavore della tecnica diretta ci sono dei dati che evidenziano una minima contrazione post-polimerizzazione, da sommare a quella del 2-3% che si ha durante la polimerizzazione dei vari strati[2]. Si può tranquillamente ovviare alla prima contrazione facendo l'ultima polimerizzazione coprendo tutto il restauro con gel di glicerina che favorisce la chiusura dei legami superficiali, riducendo così la contrazione da post-polimerizzazione[3].

La seconda contrazione è una caratteristica propria dei materiali compositi ed è presente sia che vengano utilizzati con tecnica diretta che con tecnica indiretta; la percentuale può variare in più o in meno a seconda della tipologia dei materiali usati e del loro punto di gel: un composito con un punto di gel anticipato indurrà maggiore stress, che si ripercuoterà direttamente sui margini della cavità[4].

| TABELLA 1 - FASI PER LA REALIZZAZIONE OTTIMALE DEI RESTAURI INDIRETTI |
|---|
| 1. Scelta tra tecnica diretta o indiretta: indicazioni assolute o relative alla tecnica indiretta |
| 2. Scelta del materiale: composito o ceramica |
| 3. Protezione della struttura dentinale residua: la realizzazione del "build-up" |
| 4. Principi di preparazione delle cavità per inlay, onlay, overlay |
| 5. Modalità di presa dell'impronta |
| 6. Fasi di laboratorio odontotecnico: realizzazione dei modelli master e del manufatto |
| 7. Prove cliniche del manufatto |
| 8. Cementazione adesiva: protocollo e fasi operative |


Riassunto

In questo articolo vengono prese in esame, sulla base della letteratura più recente e delle evidenze cliniche, quali sono le attuali indicazioni per la scelta dei restauri indiretti nei settori posteriori, quale materiale per la realizzazione dei manufatti ha dato i migliori risultati a lungo termine. Pertanto vengono elencate tutte quelle procedure necessarie per preservare le strutture dentarie sane residue, renderle opportunamente idonee ad accogliere i manufatti mediante preparazioni adeguate per la tipologia di materiale scelto, per facilitare la presa dell'impronta e tutte quelle fasi importantissime che si eseguono in laboratorio atte a riconsegnarci un restauro finito, pronto per la cementazione, che presenti caratteristiche ottimali di precisione, forma, colore e durata nel tempo. Si conclude con un'analisi dei cementi che le case produttrici ci mettono a disposizione per questa fase e la scelta della tipologia unitamente alla metodica più idonea per i diversi casi che ci si possono presentare.


● PAROLE CHIAVE: restauri indiretti, build-up, preparazioni, disilicato di litio, cementazione adesiva


*Summary*

*Indirect restorations in the posterior tooth*

*In this article we analyze, on the basis of the most recent literature and of the clinical evidence, which are the current indications for the choice of the indirect restorations in the posterior tooth, which material for the production of objects has given the best long term results. For this all those procedures listed are necessary to preserve the remaining healthy dental structures, to make them adapt to hold the objects with the correct preparation for the type of material chosen, to enable the grip of the print and all those really important phases which are taken out in a laboratory aimed to giving us a finished restoration, ready for cementation, which present optimal precision, shape, color, and lasting in time. We conclude with an analysis of the cements which the manufacturers give for this phase and the choice of the type united with the best method for the different cases that can emerge.*


● *KEYWORDS: indirect restoration, build-up, preparation, lithium disilicate, adhesive cementation*

Giornale Italiano di Endodonzia (2011) 25, 3–21

Disponibile su www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/gie

FOCUS

# Il restauro conservativo del dente singolo posteriore trattato endodonticamente

*The conservative restoration of single posterior endodontically treated teeth*

**Andrea Polesel** *

*Libero professionista, Arenzano (GE)*

Ricevuto il 2 dicembre 2010; accettato il 10 febbraio 2011
disponibile online il 12 giugno 2011

**PAROLE CHIAVE**
Resine composite;
Restauri;
Intarsi;
Denti trattati endodonticamente.

**Riassunto**

*Scopo:* Analizzare, attraverso una revisione della letteratura, i fattori che condizionano la scelta del restauro adesivo in composito nel dente singolo posteriore trattato endodonticamente.

*Riassunto:* Il successo a lungo termine di ogni trattamento endodontico dipende da una detersione, una sagomatura e un'otturazione tridimensionale del sistema dei canali radicolari, nel rispetto dell'anatomia originaria, con una tecnica di strumentazione il più possibile mini-invasiva, seguite da un sigillo coronale che ostacoli la ricontaminazione batterica dell'endodonto e del periapice, preferibilmente eseguiti in un'unica seduta. Gli elementi trattati endodonticamente subiscono cambiamenti irreversibili dal punto di vista anatomico, biochimico e biomeccanico che li rendono più suscettibili alla frattura e ne condizionano le scelte ricostruttive. Le resine composite, usate con tecniche adesive, sono a oggi i materiali di elezione per il restauro dei denti singoli trattati endodonticamente in presenza di una sufficiente quantità di sostanza dentale sana e di smalto cervicale. Consentono preparazioni conservative, esercitano un'azione di rinforzo sui tessuti dentali residui, sono riparabili e offrono un'estetica eccellente; in virtù di un modulo di elasticità simile a quello della dentina, garantiscono ottime performance biomeccaniche, ma soprattutto consentono il reintervento, ovvero la possibilità di eseguire un restauro protesico in un tempo successivo. Dopo revisione della letteratura recente sull'argomento, viene discusso l'iter decisionale che accompagna il clinico nella scelta fra tecnica diretta (più conservativa, ma meno frequentemente realizzabile) e tecnica indiretta (inlay, ma soprattutto onlay e overlay). Nel rispetto dei principi di bioeconomia, l'inserimento di perni endocanalari viene limitato ai casi di grave perdita di sostanza coronale, in cui è necessario ancorare il restauro alla radice. La corona completa trova indicazioni in elementi gravemente compromessi con esteso coinvolgimento dello smalto cervicale. Un isolamento del campo operatorio ottimale con diga di gomma e interventi chirurgici parodontali che ripristino una corretta ampiezza biologica sono requisiti imprescindibili di ogni restauro adesivo.

* Corrispondenza: piazza Golgi 16/1 – 16011 Arenzano (GE).
*E-mail:* andrea.polesel@libero.it

1121-4171/$ – see front matter 
doi:10.1016/j.gien.2011.05.006

# Current options concerning the endodontically-treated teeth restoration with the adhesive approach

**Marco Aurélio de CARVALHO**[I]
**Priscilla Cardoso LAZARI**[II]
**Marco GRESNIGT**[III]
**Altair Antoninha DEL BEL CURY**[IV]
**Pascal MAGNE**[III]

[I]Universidade Federal de Goiás – UFG, Dental School, Department of Stomatology Sciences, Goiania, GO, Brazil.

[II]University of Groningen, University Medical Center Groningen, Direct Restorative Department, Groningen, The Netherlands.

[III]Universidade Estadual de Campinas – Unicamp, Piracicaba Dental School, Department of Prosthodontics and Periodontology, Piracicaba, SP, Brazil.

[IV]University of Southern California – USC, Herman Ostrow School of Dentistry, Division of Restorative Sciences, Los Angeles, CA, USA.

**Declaration of Interests:** The authors certify that they have no commercial or associative interest that represents a conflict of interest in connection with the manuscript.

**Corresponding Author:**
Marco Aurélio de Carvalho
E-mail: marco_carv@hotmail.com

https://doi.org/10.1590/1807-3107bor-2018.vol32.0074

Submitted: May 10, 2018
Accepted for publication: May 29, 2018
Last revision: June 12, 2018

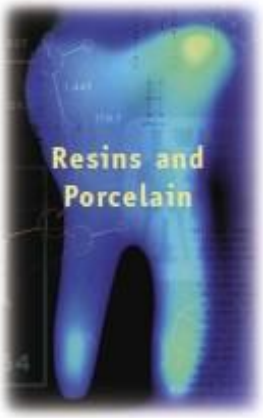
**Abstract:** Adhesive procedures have changed the way to restore endodontically treated teeth (ETT). It started with the shift from cast post-and-core to fiber post. The original focus on strength also shifted towards failure modes, revealing that catastrophic failures are still a concern when restoring endodontically-treated teeth even with fiber posts. As an alternative, postless approaches have been proposed in order to improve the chances of repair. The goal of this critical review is to present a survey of the current knowledge on adhesive approaches to restore endodontically treated teeth with and without extensive coronal tissue loss. The preservation of tooth structure of endodontically treated teeth is paramount. Partial versus full coverage of ETT, the role of the ferrule, the post type effect on catastrophic failures and postless alternatives as endocrowns and postless build-ups are reviewed. There is a consensus that the remaining tooth structure plays an important role in ETT survival, although the current literature still is contradictory on the influence of post type on root fractures as well as the benefits of avoiding a post or partially restoring a tooth. More clinical studies should be carried out with the modern postless adhesive alternatives to conventional approaches.

**Keywords:** Tooth, Nonvital; Dental Materials; Crowns; Dental Restoration Failure; Dental Bonding.

## Introduction

The optimal way to restore teeth after endodontic treatment continues to remain a controversial topic of heated debate to this day. Endodontically treated teeth (ETT) present with significantly different mechanical properties compared to vital teeth.[1,2] The modifications in the biomechanical properties and structural integrity of the teeth are most-likely attributed to the volumetric loss of the hard tissues, extent of carious lesion, fracture propagation, final cavity preparation in addition to the access cavity prior to endodontic therapy.[3-6,6,7]

There is still a debate regarding which technique would be ideal for ETT restoration, since those teeth are considered to have a higher risk of fracture than vital teeth.[4,7,8,9,10] From a biomimetic perspective, the preservation and conservation of tooth structure is paramount in maintaining the balance between biological, mechanical, adhesive, functional, and esthetic




# Composite Resins and Bonded Porcelain: The Postamalgam Era?

Pascal Magne, DMD, PhD

## Abstract

The growing demand of patients for esthetic or metal-free restorations, together with the ongoing interest of the dental profession for tissue-preserving materials have led to the actual development of posterior adhesive restorations. It is now clearly established that a new biomimetic approach to restorative dentistry is possible through the structured use of "tooth-like" restorative materials (composite resins and porcelain) and the generation of a hard tissue bond (enamel and dentin bonding). Scientific studies and clinical experience have validated use of bonded tooth-colored restorations, and we may have entered the so-called "postamalgam era."

These significant changes have already impacted daily general practice, including pediatric dentists in California, but it is now critical to assure that the corresponding evidence-based process is integrated to the predoctoral programs statewide and nationwide. This paper reviews the foundations of this evolution, based on maximum tissue preservation and sound biomechanics, the so-called "biomimetic principle." Using scientific evidence and clinical experience, a model for the adequate use of current restorative systems is presented. This work, illustrated with cases with up to 10 and 14 years' follow-up, sets the ground rules for the clinical performance of the posterior esthetic restoration. Important considerations about tooth preparation, matrix techniques, layering methods, immediate dentin sealing and base lining are presented.

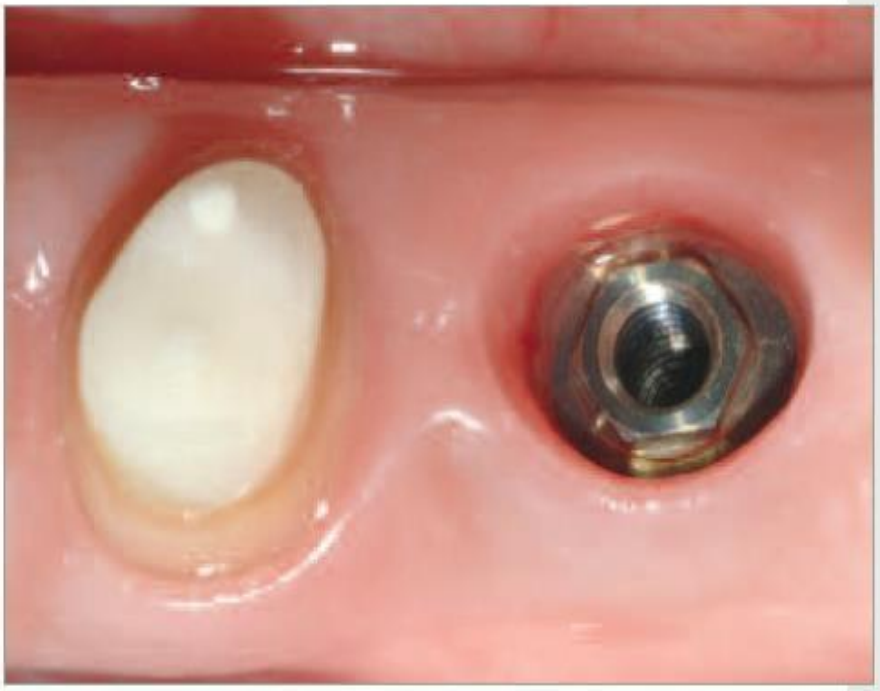
It is common knowledge that patients' requests and clinicians' interest in esthetic restorations are not limited to anterior teeth. As a result, posterior tooth-colored adhesive restorative techniques have grown considerably over the last decade. It was clearly established that a new biomimetic approach to restorative dentistry was possible through the structured use of "tooth-like" restorative materials (composite resins and porcelain) and the generation of a hard tissue bond (enamel and dentin bonding).[1] Scientific studies and clinical experience have validated use of bonded tooth-colored restorations (see Section 3.) and we may have entered the so-called postamalgam era.[2] The changes toward esthetic and adhesive dentistry have largely impacted daily clinical practice,

**Author** / Pascal Magne, DMD, PhD, is associate professor with tenure, chair of Esthetic Dentistry, Division of Primary Oral Health Care, University of Southern California School of Dentistry.

**Acknowledgments** / The author wishes to express gratitude to the Faculty Esthetic Update group, Drs. T. Donovan, G. Harmatz, S. Jivraj, R. Kahn, B. Keselbrenner, T. Kim, R. Leung, C.R. Philips, C. Shuler, as well as dental technologists M. Magne and D. Cascione, Division of Primary Oral Health Care, USC School of Dentistry for helpful contribution and discussions during the evidence-based revision of the curriculum at USC School of Dentistry. Special thanks to Dr. Donovan for the review of the English draft.

# Restauri adesivi dei settori posteriori con margini cervicali subgengivali: nuova classificazione e approccio terapeutico differenziato

**Marco Veneziani**
Professore a contratto Università degli Studi di Pavia.
Socio attivo Accademia Italiana di Conservativa.
Libero professionista in Vigolzone (PC)



Corrispondenza: Dr Marco Veneziani
Via Roma, 57 - 29020 Vigolzone (PC).
Tel/Fax 0523-870362; Cell:3351435187; E-mail: marco.veneziani@nexh.biz

DENTAL MATERIALS 34 (2018) 1466–1473

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/dema

# Endocrown restorations: Influence of dental remnant and restorative material on stress distribution☆

João Paulo Mendes Tribst[a], Amanda Maria de Oliveira Dal Piva[a,*], Camila Ferreira Leite Madruga[a], Marcia Carneiro Valera[b], Alexandre Luiz Souto Borges[a], Eduardo Bresciani[b], Renata Marques de Melo[a]

[a] Department of Dental Materials and Prosthodontics, São Paulo State University (Unesp), Institute of Science and Technology, Av. Eng. Francisco José Longo, nº 777, Jardim São Dimas, 12245-000 São José dos Campos, SP, Brazil
[b] Department of Restorative Dentistry, São Paulo State University (Unesp), Institute of Science and Technology, Av. Eng. Francisco José Longo, nº 777, Jardim São Dimas, 12245-000 São José dos Campos, SP, Brazil

ARTICLE INFO

Article history:
Received 13 December 2017
Received in revised form 8 May 2018
Accepted 7 June 2018

Keywords:
Ceramics
Monoblock restoration
Endodontically treated teeth
Finite element analysis
Dental restoration failure

ABSTRACT

Objective. The goal of this study was to evaluate the stress distribution in a tooth/restoration system according to the factors "amount of dental remnant" (3 levels) and "restorative material" (2 levels).

Methods. Three endodontically treated maxillary molars were modeled with CAD software for conducting non-linear finite element analysis (FEA), each with a determined amount of dental remnant of 1.5, 3, or 4.5 mm. Models were duplicated, and half received restorations in lithium disilicate (IPS e.max CAD), while the other half received leucite ceramic restorations (IPS Empress CAD), both from Ivoclar Vivadent (Schaan, Liechtenstein). The solids were imported to analysis software (ANSYS 17.2, ANSYS Inc., Houston, TX, USA) in STEP format. All contacts involving the resin cement were considered no-separation, whereas between teeth and fixation cylinder, the contact was considered perfectly bonded. The mechanical properties of each structure were reported, and the materials were considered isotropic, linearly elastic, and homogeneous. An axial load (300 N) was applied at the occlusal surface (triploidism area). Results were determined by colorimetric graphs of maximum principal stress (MPS) on tooth remnant, cement line, and restoration.

Results. MPS revealed that both factors influenced the stress distribution for all structures; the higher the material's elastic modulus, the higher the stress concentration on the restoration and the lower the stress concentration on the cement line. Moreover, the greater the dental crown remnant, the higher the stress concentration on the restoration. Thus, the remaining dental tissue should always be preserved.

* Corresponding author.
E-mail addresses: joao.tribst@ict.unesp.br (J.P.M. Tribst), amanda.piva@ict.unesp.br (A.M.d.O. Dal Piva), camila.domingues@ict.unesp.br (C.F.L. Madruga), marcia@ict.unesp.br (M.C. Valera), aleborges@ict.unesp.br (A.L.S. Borges), eduardob@ict.unesp.br (E. Bresciani), renata.marinho@ict.unesp.br (R.M. de Melo).

☆ This research was recently awarded with an honorable mention as Oral presentation on the 34th Brazilian Society of Dental Research — SBPqO, the Brazilian division of the International Association for Dental Research — IADR, Campinas, BRA.

https://doi.org/10.1016/j.dental.2018.06.012

THE JOURNAL OF PROSTHETIC DENTISTRY

SYSTEMATIC REVIEW

# Survival and success of endocrowns: A systematic review and meta-analysis

Raghad A. Al-Dabbagh, BDS, MClinDent Pros, MPros CRS Edin, PhD


## ABSTRACT

**Statement of problem.** Endocrowns are a monoblock type of restoration that use the pulp chamber and remaining coronal tooth structure as a means of retention. However, data on their long-term survival and success rates as compared with conventional crowns are lacking.

**Purpose.** The purpose of this systematic review and meta-analysis was to collate published work on endocrowns to assist clinicians in making decisions on when and whether they are an appropriate restorative option with a predictable outcome for extensively damaged endodontically treated teeth.

**Material and methods.** Databases such as PubMed (MEDLINE), Scopus, EMBASE, Cochrane library, and Google Scholar were searched up to June 2019 for clinical and in vitro studies on endocrown survival and success rates. For the meta-analysis, endocrown and conventional crown survival and success rates were compared, and the pooled effects were presented as relative risks and 95% confidence intervals using a random effects model.

**Results.** Ten studies fulfilled the inclusion criteria (3 clinical and 7 in vitro) and were included in the systematic review. The meta-analysis of the clinical studies showed an estimated overall 5-year survival rate of 91.4% for endocrowns and 98.3% for conventional crowns. The estimated overall 5-year success rates were 77.7% for endocrowns and 94% for conventional crowns. There were no significant differences in overall survival or success estimates between the assessed restorations ($P>.05$).

**Conclusions.** Additional well-designed clinical studies with long-term assessment are needed; however, endocrowns appear to be a promising conservative restorative option with acceptable long-term survival for endodontically treated posterior teeth in selected patients. (J Prosthet Dent 2020;■:■-■)


The successful restoration of endodontically treated teeth is dependent on the type and quality of the coronal restoration.[1-4] Endodontically treated teeth restored with crowns have a 5-year survival rate similar to vital teeth restored with crowns (94.2% versus 95%).[1,5] However, in the absence of cuspal coverage (restored with composite resin), endodontically treated teeth have a lower success rate, with a 5-year survival rate of 63%.[1] The improved survival of teeth treated endodontically with satisfactory coronal cuspal coverage has been attributed to a reduction in microleakages and the preservation and protection of the remaining tooth structure.[6,7] Immediate placement of a satisfactory coronal restoration has been reported to reduce microleakage and subsequently decrease the risk of endodontic treatment failure,[6] while cuspal coverage and preservation of the remaining coronal tooth structure have been reported to improve fracture resistance and the outcome of the endodontically treated tooth.[2,6,7]

Preparation designs for coronal restorations of endodontically treated teeth have become more conservative with advances in adhesive dentistry.[8] Such designs include incorporating fewer mechanical retentive features such as undercuts, grooves, or boxes,[8] with retention being mainly dependent on adhesion to the tooth structure.[8]

Endocrowns are conservative coronal restorations that have been used to restore endodontically treated teeth with significant loss of coronal tooth structure. They are

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Assistant Professor and Consultant in Prosthodontics, Oral and Maxillofacial Rehabilitation Department, Faculty of Dentistry, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia.

# From 'Direct Versus Indirect' Toward an Integrated Restorative Concept in the Posterior Dentition

NJM Opdam • R Frankenberger • P Magne



**Clinical Relevance**

The decision whether a required dental restoration should be direct or indirect is made daily in clinical practice. Guidelines for this decision are presented.


## SUMMARY

**Traditionally, indirect restorations are expected to have better longevity than direct restorations. The introduction of adhesive dentistry and the minimally invasive approach of restorative treatment has changed this. In this article, the differences in longevity between direct and indirect restorations in the posterior dentition are explained. In addition, the advantages and disadvantages of direct and indirect restorations placed in a minimally invasive way and using a proper adhesive technique are described.**



*Niek J. M. Opdam, PhD, DDS, Radboud Institute for Molecular Life Sciences, Department of Dentistry, Radboud university medical center, Nijmegen, The Netherlands

Roland Frankenberger, DMD, PhD, Chair, Department of Operative Dentistry and Endodontics, Philipps University of Marburg and University Hospital Giessen and Marburg, Campus Marburg, Marburg, Germany

Pascal Magne, D.M.D., M.Sc., Ph.D, The Don and Sybil Harrington Professor of Esthetic Dentistry, Herman Ostrow School of Dentistry of USC, Division of Restorative Sciences

*Corresponding author: PO Box 9101, Nijmegen, NL 6500 HB, Netherlands; e-mail: niek.opdam@radboudumc.nl


DOI: 10.2341/15-126-LIT

## INTRODUCTION

Numerous dental restorations are placed each day in human teeth, mainly to restore defects caused by caries but also those caused by tooth wear (mechanical and erosive) and fracture.[1] In addition, because dental restorations have limited longevity, a significant part of restorative work by dentists includes replacing defective existing restorations.[2,3]

Basically, restoration replacement results in a restorative cycle of defective restorations being replaced by larger restorations that will someday fail again, which will lead to even larger restorations, possible root canal therapy, more risk for complications, and eventually tooth loss. This restorative cycle of death of the tooth was described by Elderton[4] in 1988 and Simonsen[5] in 1991. To reduce and maybe even interrupt this restorative cycle, which could possibly lead to prolonged tooth retention, different approaches must be considered:

- Postpone the first restoration as long as possible by using advanced diagnostic methods and caries detection techniques.
- Use less aggressive excavation and caries removal methods to maintain pulp vitality.

# Posterior indirect adhesive restorations (PIAR): preparation designs and adhesthetics clinical protocol

**Federico Ferraris,** DDS
Private Practice, Alessandria, Italy

Correspondence to: Dr Federico Ferraris
Spalto Borgoglio 81, 15121 Alessandria, Italy; Tel: +39 0131442005; Email: info@federicoferraris.com; www.federicoferraris.com

# Full-Mouth Adhesive Rehabilitation of a Severely Eroded Dentition: The Three-Step Technique. Part 2.

**Francesca Vailati,** MD, DMD, MSc
Senior Lecturer, Dept of Fixed Prosthodontics and Occlusion
School of Dental Medicine, University of Geneva
Switzerland

**Urs Christoph Belser,** DMD, Prof Dr med dent
Chairman, Dept of Fixed Prosthodontics and Occlusion
School of Dental Medicine, University of Geneva
Switzerland

Correspondence to: Dr Francesca Vailati
University of Geneva, Dept of Fixed Prosthodontics and Occlusion, Rue Barthelemy-Menn 19, 1205 Geneva, Switzerland;
e-mail: Francesca.vailati@medecine.unige.ch.

# Ceramic Inlays and Onlays: Clinical Procedures for Predictable Results

ALFREDO MEYER FILHO, DDS, MS*
LUIZ CLOVIS CARDOSO VIEIRA, DDS, MS, PhD†
ÉLITO ARAUJO, DDS, MS, PhD‡
LUIZ NARCISO BARATIERI, DDS, MS, PhD†

ABSTRACT

The use of ceramics as restorative materials has increased substantially in the past two decades. This trend can be attributed to the greater interest of patients and dentists in this esthetic and long-lasting material, and to the ability to effectively bond metal-free ceramic restorations to tooth structure using acid-etch techniques and adhesive cements. The purpose of this article is to review the pertinent literature on ceramic systems, direct internal buildup materials, and adhesive cements. Current clinical procedures for the planning, preparation, impression, and bonding of ceramic inlays and onlays are also briefly reviewed. A representative clinical case is presented, illustrating the technique.

CLINICAL SIGNIFICANCE

When posterior teeth are weakened owing to the need for wide cavity preparations, the success of direct resin-based composites is compromised. In these clinical situations, ceramic inlays/onlays can be used to achieve esthetic, durable, and biologically compatible posterior restorations.

(*J Esthet Restor Dent* 15:338–352, 2003)

The restoration of posterior teeth with tooth-colored materials is not a new trend in restorative dentistry. Porcelain inlays were used in the nineteenth century, but the lack of an adequate adhesive cementing medium along with the poor esthetics of those early porcelains yielded less than optimal results.[1] In the early 1980s Simonsen and Calamia reported on the technique of resin composite adhesion to porcelain by means of acid etching the porcelain surface with hydrofluoric acid.[2] The strong bond afforded by this technique allowed the first adhesive porcelain restorations to be made on anterior teeth, as reported by Horn in 1983.[3] The use of dental ceramics to restore posterior teeth was a logical consequence of the success of these first adhesive porcelain restorations. In addition, the introduction in 1985 of specific dental ceramics for use in posterior teeth,[4] as well as the continuous development of ceramic materials with improved mechanical properties, allowed these materials to be used free of metal.[5]

New processing methods of dental ceramics include fabrication techniques such as the lost wax technique and centrifugal casting (castable glass-ceramic), the pressure injection of ceramic ingots (pressable ceramics), and the computer-aided design and manu-

*Graduate student, Department of Operative Dentistry, and associate professor, Department of Dental Clinics, Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil
†Professor, Department of Operative Dentistry, Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil
‡Professor, Department of Dental Clinics, Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil

# A New Classification System for All-Ceramic and Ceramic-like Restorative Materials

Stefano Gracis, DMD, MSD[a]/Van P. Thompson, DDS, PhD[b]/Jonathan L. Ferencz, DDS[c]/
Nelson R.F.A. Silva, DDS, MSc, PhD[d]/Estevam A. Bonfante, DDS, MSc, PhD[e]

Classification systems for all-ceramic materials are useful for communication and educational purposes and warrant continuous revisions and updates to incorporate new materials. This article proposes a classification system for ceramic and ceramic-like restorative materials in an attempt to systematize and include a new class of materials. This new classification system categorizes ceramic restorative materials into three families: *(1)* glass-matrix ceramics, *(2)* polycrystalline ceramics, and *(3)* resin-matrix ceramics. Subfamilies are described in each group along with their composition, allowing for newly developed materials to be placed into the already existing main families. The criteria used to differentiate ceramic materials are based on the phase or phases present in their chemical composition. Thus, an all-ceramic material is classified according to whether a glass-matrix phase is present (glass-matrix ceramics) or absent (polycrystalline ceramics) or whether the material contains an organic matrix highly filled with ceramic particles (resin-matrix ceramics). Also presented are the manufacturers' clinical indications for the different materials and an overview of the different fabrication methods and whether they are used as framework materials or monolithic solutions. Current developments in ceramic materials not yet available to the dental market are discussed. *Int J Prosthodont 2015;28:227–235. doi: 10.11607/ijp.4244*

Ceramics have been the mainstay of esthetic dentistry for more than 100 years. Originally in the naturally occurring feldspathic form, ceramics were used primarily for anterior teeth as high fusing porcelain jacket crowns, denture teeth, and partial coverage. Beginning with John McLean's introduction of aluminous porcelain in the mid-1960s,[1] there have been continuous improvements in strength, esthetics, and methods of fabrication, resulting in dozens of products for clinicians to choose from.

[a]*Private Practice, Milan, Italy.*
[b]*Professor, Department of Biomaterials, Biomimetics and Biophotonics, King's College London, Guys Hospital, London, United Kingdom.*
[c]*Clinical Professor, Department of Prosthodontics, New York University College of Dentistry; Private Practice, New York, New York, USA.*
[d]*Associate Professor, Department of Restorative Dentistry, Federal University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.*
[e]*Assistant Professor, Department of Prosthodontics, University of São Paulo—Bauru College of Dentistry, Bauru, São Paulo, Brazil.*

**Correspondence to:** *Dr Stefano Gracis, Via Brera, 28/a, 20121 Milan, Italy. Email: sgracis@dentalbrera.com*



Due to the high number of products available and the speed at which new products are being introduced, today's clinician faces a complex decision process when choosing a ceramic restorative material for a particular indication. The selection is seldom made on the basis of a thorough understanding of the materials' characteristics. More often, it is based on criteria such as strength measured in vitro, degree of translucency, manufacturing techniques, the preference of the dental laboratory technician, and even advertising claims.

A classification system of the ceramic materials used in dentistry is useful for a variety of purposes, including communication and education. Ideally, a classification system should be helpful in providing clinically relevant information about where to use the material (anterior versus posterior), for what type of restoration (partial versus full, short versus long-span), and how to lute it (adhesively versus traditionally). Different classification systems have been proposed that focus on clinical indications, composition, ability to be etched, processing methods, firing temperatures, microstructure, translucency, fracture resistance, and antagonist wear.[2–6] These classifications, however, tend to be either vague or imprecise, and they do not easily allow for the inclusion of new restorative materials.

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

# Comparative in vitro wear resistance of CAD/CAM composite resin and ceramic materials

Li Zhi, DMD,[a] Tissiana Bortolotto, Dr, PhD,[b] and Ivo Krejci, DMD, PhD[c]

## ABSTRACT

**Statement of problem.** Composite resin is a promising option in computer-aided design and computer-aided manufacturing (CAD/CAM) dentistry; however, the wear resistance of composite resin remains a primary concern.

**Purpose.** The purpose of this in vitro study was to evaluate the wear resistance of 5 CAD/CAM materials (n=10), consisting of 4 composite resins (3M Lava Ultimate, Kerr experimental composite resin material, Vita Enamic, 3M Paradigm MZ100) and 1 ceramic (Vita Mark II) in contact with natural human enamel cusps.

**Material and methods.** Specimens were loaded into a computer-controlled mastication simulator and subjected to 200 000 mechanical cycles (49 N) against natural human enamel simultaneously with 500 thermal cycles (5°C to 50°C to 5°C). The wear resistance was analyzed by measuring the vertical substance loss (the maximum depth of the worn area) in the contact point area of the specimen. The worn surfaces were observed by scanning electron microscopy to determine the wear patterns.

**Results.** Vita Mark II exhibited the best wear resistance among the tested materials, followed by 3M Lava Ultimate, Vita Enamic, and 3M Paradigm MZ100. The Kerr experimental material exhibited the lowest wear resistance, yet its results were not significantly different from those of the 3 other composite resin blocks ($P>.05$).

**Conclusions.** Within the limitations of this in vitro study, the wear resistance of composite resin blocks in contact with enamel cusps was significantly lower than that of a ceramic block. (J Prosthet Dent 2016;115:199-202)

The CEREC chairside computer-aided design and computer-aided (CAD/CAM) manufacturing system was introduced to dentistry more than 25 years ago.[1] The low rate of restoration fractures and long-term clinical success rates have confirmed the effectiveness of the CEREC system as a dependable, esthetic restorative option for patients, and ceramics were originally the predominant material used for CEREC systems.[2] Ceramics are known for their high biocompatibility, strength, and esthetics, as they can imitate the characteristics of human tooth structure.[3,4] However, the abrasiveness of these materials against an enamel antagonist is still a clinical concern.[5-7] The Vita Mark II ceramic material has been found to be one of the best performing materials in terms of wear resistance.[8] However, according to wear studies, although the CAD/CAM composite resin 3M MZ100 showed greater wear, the total wear (enamel and tested material) was significantly lower than that of CAD/CAM ceramic material Vita Mark II. As a result, composite resin material was considered preferable for patients with high occlusal activity when the restoration was in contact with natural enamel.[9] Studies have also shown that enamel wear produced by composite resin was lower than that produced by zirconia or glass ceramic, and only composite resin did not increase the enamel surface roughness after wear testing.[6,10]

Fractures are the primary failure mechanism for CEREC restorations, whereas composite resin restorations show better fracture resistance.[7] Schlichting et al[11] found that CAD/CAM composite resin ultrathin occlusal veneers had increased fatigue resistance compared with the CAD/CAM ceramic materials evaluated. Composite resin materials are also easy to mill, can be repaired

[a]Assistant, Department of Stomatology, Beijing University, People's Hospital, Beijing, China.
[b]Research Section Head, Division of Cariology and Endodontology, School of Dental Medicine, University of Geneva, Geneva, Switzerland.
[c]Professor, Division of Cariology and Endodontology, School of Dental Medicine, University of Geneva, Geneva, Switzerland.

# Evidence-based concepts and procedures for bonded inlays and onlays. Part II. Updated guidelines for cavity preparation and restoration fabrication

**Giovanni Tommaso Rocca,** DMD
Senior lecturer, Division of Cariology and Endodontology,
University Clinic of Dental Medicine, Geneva, Switzerland

**Nicolas Rizcalla,** DMD
Senior lecturer, Division of Cariology and Endodontology,
University Clinic of Dental Medicine, Geneva, Switzerland

**Ivo Krejci,** Prof, DMD,PD
President, University Clinic of Dental Medicine, Geneva, Switzerland
Director, Department of Preventive Dental Medicine and Primary Dental Care,
University Clinic of Dental Medicine, Geneva, Switzerland
Head, Division of Cariology and Endodontology,
University Clinic of Dental Medicine, Geneva, Switzerland

**Didier Dietschi,** DMD, PhD, PD
Senior lecturer, Division of Cariology and Endodontology,
University Clinic of Dental Medicine, Geneva, Switzerland
Adjunct Professor, Department of Comprehensive Dentistry,
Case Western University, Cleveland, Ohio
Private Education Center, The Geneva Smile Center, Geneva, Switzerland

Correspondence to: Giovanni Tommaso Rocca, DMD
School of Dentistry, Faculty of Medicine, University of Geneva, 19 rue Barthélémy-Menn, 1205 Geneva, Switzerland;
E-mail:giovanni.rocca@unige.ch

DENTAL MATERIALS 36 (2020) 854–864

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/dema

# A comparison of mvM stress of inlays, onlays and endocrowns made from various materials and their bonding with molars in a computer simulation of mastication – FEA☆

Beata Dejak[a,*], Andrzej Młotkowski[b]

[a] Department of Prosthetic Dentistry, Medical University of Łódź, Łódź, Poland
[b] Department of Strength of Materials and Structures, Technical University of Łódź, Łódź, Poland

ARTICLE INFO

*Article history:*
Received 2 February 2020
Accepted 14 April 2020

*Keywords:*
Composite
Ceramic
Inlays
Onlays
Endocrowns
Modified von Mises failure criterion
Bond stresses at the cement-tooth interface
3D finite element analysis
Simulation of mastication

ABSTRACT

*Objectives.* The purpose of the study was to compare the mvM stresses occurring in inlays, onlays and endocrowns made from different materials and their bonding with molars in a computer simulation of mastication.

*Methods.* The study was conducted using the finite elements method with contact elements. Sixteen 3D first molar models were created of a intact tooth – T; a tooth with a ceramic inlay – IN; a tooth with an onlay – ON; and a tooth with an endocrown – EN. The restorations were made of: Comp – resin nanoceramic; Hc – hybrid ceramic; Le – leucite ceramic; Dlit – lithium disilicate; and Zr – zirconia. Computer simulations of mastication were performed. The equivalent stresses according to the modified von Mises criterion (mvM) were calculated in model materials and contact stresses at the interface cement–dental tissue around the examined restorations.

*Results.* The highest equivalent mvM stresses were concentrated in buccal margins of inlays. The mvM stresses recorded in onlays were 1.6–5 times lower than those found in inlays, while in endocrowns they were 2.3–6.5 times lower. Around the onlays and endocrowns, in tooth structures and luting cement, mvM stresses were significantly lower compared to teeth restored with inlays. The tensile and shear contact stresses between inlays and teeth were several times lower than under another restorations.

The highest stresses (58.5 MPa) occurred in the zirconia inlay. The stresses observed in the enamel of a tooth restored with an INZr inlay were half those noted in INComp, and a third of those observed in cement. Tensile contact stresses at the interface between the INZr inlay and dental tissue were 4.5 times lower than in the INComp, and the shear stresses were more than 7 times lower.

*Significance.* The highest values and unfavorable of stress levels occurred in teeth restored with inlays. Cavities MOD in molars should be reconstructed with cusp-covering restorations. The endocrown in molars should withstand physiological loading.

☆ This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
* *Corresponding author at:* Department of Prosthetic Dentistry, Medical Faculty, Division of Dentistry, Chair of Restorative Dentistry, Medical University of Łódź, ul. Pomorska 251, 92-213 Łódź, Poland.
E-mail address: beata.dejak@umed.lodz.pl (B. Dejak).
https://doi.org/10.1016/j.dental.2020.04.007

THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL SCIENCE

# Survival rate of lithium disilicate restorations at 4 years: A retrospective study

Taiseer A. Sulaiman, BDS,[a] Alex J. Delgado, DDS, MS,[b] and Terence E. Donovan, DDS[c]


## ABSTRACT

**Statement of problem.** Ceramic restorations are frequently being placed due to the esthetic demand and the cost of noble metals that has increased considerably. One major disadvantage of ceramic restoration is failure of the material due to fracture by crack propagation. In vitro studies are of little clinical significance and in vivo studies are too short to support clinical success.

**Purpose.** The purpose of this retrospective study was to evaluate the failure rate of lithium disilicate restorations (monolithic and layered) at 4 years.

**Material and methods.** Data were collected over 45 months from 2 commercial laboratories. Restorations were categorized into monolithic restorations and layered restorations. Each category was further classified into complete coverage single crowns, fixed dental prostheses, e.max veneers, and inlay/onlay restorations. Failure rates were compared and analyzed using Chi-square ($\alpha$=.05).

**Results.** A total of 21 340 restorations were evaluated in this study and included 15 802 monolithic restorations and 5538 layered restorations. The failure rate for single crown monolithic restorations was 0.91% and was 1.83% for single crown layered restorations. For fixed dental prostheses, 4.55% of monolithic restorations failed. For e.max veneers, 1.3% of monolithic veneers fractured and 1.53% of layered veneers fractured. Of the inlay/onlay restorations group, 1.01% of monolithic restorations fractured.

**Conclusion.** In the short term (45 months), restorations fabricated with the lithium disilicate material (IPS e.max) had relatively low fracture rates. Layered single crowns fractured at approximately 2 times the rate of monolithic crowns. (J Prosthet Dent 2015;114:364-366)


Ceramic restorations are frequently placed in contemporary dental practices. Some of these restorations are primarily placed for esthetic reasons. Others are placed because the cost of noble metals has increased considerably and most ceramic alternatives are less expensive than metal ceramic restorations.[1]

Many of the new ceramic systems have impressive physical and mechanical properties.[2] However, clinical longevity cannot be accurately predicted based on these properties or from in vitro load-to-failure tests.[3-6] Most of these systems have been brought to market with almost no independent clinical testing. Ninety-five percent of metal ceramic restorations are intact and functioning at 11 years.[7] Dr Peter Scharer suggested that before a clinician uses a new ceramic system, the manufacturer should provide data from independent clinical trials that indicate 95% survival at 3 or preferably 5 years.[8]

The problem facing clinicians is that data from independent clinical trials are rarely available in the first 5 years after the introduction of a new ceramic system, and manufacturers are quite aggressive in their marketing strategies. The problem for the manufacturers is that clinical trials are both expensive and time-consuming and that competition in the marketplace is fierce.

This study was undertaken to provide useful data relative to the early survival rates of lithium disilicate materials, specifically one popular system, the IPS e.max restoration. (Ivoclar Vivadent). IPS e.max is a lithium disilicate glass-based material, in which small needle-shaped crystals compress the surrounding glass matrix during cooling. Therefore, IPS e.max has a high flexural strength (400 MPa)[9] and has become popular in recent years. It is provided in two different forms, the more popular being monolithic IPS e.max, which is milled or pressed and then stained. Monolithic crowns tend to be relatively strong, because only a single material is involved and there is no veneering layer.

[a]Visiting scholar, Department of Operative Dentistry, School of Dentistry, University of North Carolina, Chapel Hill, NC; and Doctoral student, Department of Prosthetic Dentistry, Institute of Dentistry, University of Turku, Turku, Finland.
[b]Clinical Assistant Professor, Department of Restorative Sciences Division of Operative Dentistry, University of Florida, Gainesville, Fla.
[c]Professor and Section Head, Biomaterials Sciences, Department of Operative Dentistry, University of North Carolina, Chapel Hill, NC.

JOURNAL OF PROSTHODONTIC RESEARCH 60 (2016) 72–84

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/jpor

Review

# Advancements in CAD/CAM technology: Options for practical implementation

Tariq F. Alghazzawi BDS, MS, MSMtE, PhD[a,b,*]

[a] Department of Prosthetic Dental Sciences, College of Dentistry, Taibah University, Medina, Kingdom of Saudi Arabia
[b] Department of Materials Science and Engineering, School of Engineering, The University of Alabama at Birmingham, United States

ARTICLE INFO

Article history:
Received 26 October 2015
Received in revised form
10 December 2015
Accepted 16 January 2016
Available online 28 February 2016

Keywords:
CAD/CAM
Milling
3D printing
Scanner
Digital impression
Virtual articulator

ABSTRACT

*Purpose:* The purpose of this review is to present a comprehensive review of the current published literature investigating the various methods and techniques for scanning, designing, and fabrication of CAD/CAM generated restorations along with detailing the new classifications of CAD/CAM technology.

*Study selection:* I performed a review of a PubMed using the following search terms "CAD/CAM, 3D printing, scanner, digital impression, and zirconia". The articles were screened for further relevant investigations. The search was limited to articles written in English, published from 2001 to 2015. In addition, a manual search was also conducted through articles and reference lists retrieved from the electronic search and peer-reviewed journals.

*Results:* CAD/CAM technology has advantages including digital impressions and models, and use of virtual articulators. However, the implementation of this technology is still considered expensive and requires highly trained personnel. Currently, the design software has more applications including complete dentures and removable partial denture frameworks. The accuracy of restoration fabrication can be best attained with 5 axes milling units. The 3D printing technology has been incorporated into dentistry, but does not include ceramics and is limited to polymers. In the future, optical impressions will be replaced with ultrasound impressions using ultrasonic waves, which have the capability to penetrate the gingiva non-invasively without retraction cords and not be affected by fluids.

*Conclusion:* The coming trend for most practitioners will be the use of an acquisition camera attached to a computer with the appropriate software and the capability of forwarding the image to the laboratory.



## Contents

1. Introduction . . . 73
2. CAD/CAM components . . . 73
3. General classification of CAD/CAM systems . . . 73

* Correspondence to: P.O. Box 51209, Riyadh, 11543, Saudi Arabia.
E-mail address: drtariq05@gmail.com.

http://dx.doi.org/10.1016/j.jpor.2016.01.003
1883-1958/

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

# Marginal adaptation of CAD-CAM onlays: Influence of preparation design and impression technique

Fernanda Ferruzzi Lima, DDS, MS, PhD,[a] Constantino Fernandes Neto,[b] José H. Rubo, DDS, MS, PhD,[c] Gildo Coelho Santos Jr, DDS, MS, PhD,[d] and Maria Jacinta Moraes Coelho Santos, DDS, MS, PhD[e]

## ABSTRACT

**Statement of problem.** Factors that may affect the marginal adaptation of computer-aided design and computer-aided manufacturing (CAD-CAM) restorations include preparation design, impression technique, and CAD-CAM system. The influence of impression technique and preparation design on CAD-CAM partial coverage restorations has not been fully addressed.

**Purpose.** The purpose of this in vitro study was to investigate the influence of direct and indirect digital scanning techniques and 2 preparation designs on the marginal adaptation of CAD-CAM onlays.

**Material and methods.** Two mesio-occlusal buccal onlay preparations with reduction of the mesiobuccal cusp were made: conventional preparation (CP) with a 1.2-mm modified shoulder margin and modified preparation (MP) flat cuspal reduction without shoulder. Virtual models were generated from each preparation by using a digital scanner (BlueCam; Dentsply Sirona) from the plastic teeth (direct digital scan) or from the stone dies (indirect digital scan). Onlays were designed using a CAD-CAM system (CEREC 4.0; Dentsply Sirona), and nanoceramic resin blocks (Lava Ultimate Restorative; 3M ESPE) were milled using the CEREC MCX milling machine. Marginal discrepancy was evaluated using an optical stereomicroscope at ×25 magnification in 18 locations distributed along the margins of the preparation. The data were analyzed by using 3-way ANOVA followed by the Tukey HSD test ($\alpha$=.05).

**Results.** CP presented a statistically significant reduced average marginal adaptation (59 ±50 μm) than did MP (69 ±58 μm) ($P$<.001). The Tukey HSD test showed the presence of a significantly larger marginal discrepancy in the mesial and buccal locations of MP when compared with CP. Regarding impression techniques, the buccal location presented the smallest average marginal discrepancy in restorations fabricated with indirect impression when compared with direct impression (42 ±33 μm and 60 ±39 μm) ($P$<.001).

**Conclusions.** The results showed that conventional preparation with a modified shoulder margin presented improved marginal adaptation compared with modified preparation with flat cuspal reduction. Direct and indirect digital scanning techniques produced restorations within a clinically acceptable range; however, the indirect scanning technique resulted in the fabrication of restorations with superior marginal adaptation on the buccal location. (J Prosthet Dent 2018;120:396-402)

Tooth-colored partial-coverage indirect restorations are esthetic and conservative treatment options for teeth weakened by caries or fractures. When replacing multisurface direct restorations, such restorations may provide enhanced occlusal and proximal contours and protection to the remaining tooth structure by covering cusps.[1,2] Both ceramic and composite resin materials are indicated for posterior indirect restorations, providing esthetics and clinical longevity.[3,4] Computer-aided design and computer-aided manufacturing (CAD-CAM) systems provide an alternative to the conventional method of fabricating high-quality indirect restorations, reducing time and cost.[4]

Industrially controlled prefabricated materials that present less porosity and fewer flaws may improve the final quality of the restoration.[5] Additionally, these systems

Materials supplied by 3M ESPE.

[a]Adjunct Professor, Department of Prosthodontics, Bauru School of Dentistry, University of São Paulo, Bauru, Brazil.
[b]Predoctoral student, Bauru School of Dentistry, University of São Paulo, Bauru, Brazil.
[c]Associate Professor, Department of Prosthodontics, Bauru School of Dentistry, University of São Paulo, Bauru, Brazil.
[d]Associate Professor, Department of Restorative Dentistry, Schulich School of Medicine & Dentistry, Western University, London, Ontario, Canada.
[e]Associate Professor, Department of Restorative Dentistry, Schulich School of Medicine & Dentistry, Western University, London, Ontario, Canada.

Article

# Evidence-based concepts and procedures for bonded inlays and onlays. Part III. A case series with long-term clinical results and follow-up

DIETSCHI, Didier, SPREAFICO, Roberto Carlo

**Abstract**

This third article in this series (Part III) aims to present new clinical results and long-term follow-up of resin composite inlays and onlays using the modern clinical concepts presented in the Part I and Part II articles. These revised protocols have contributed to eliminating the most frequent difficulties related to the preparation, isolation, impression taking, and cementation of tooth-colored inlays and onlays. This clinical report presents a series of 25 cases of indirect or semidirect inlays and onlays (intra- and extraoral techniques) made of microhybrid and nanohybrid composites with 6- to 21-year follow-ups. The restoration performance was assessed through clinical examination, intraoral radiographs, and clinical photographs. The overall clinical assessment aimed to confirm the absence (success) or presence (failure) of decay or restoration fracture, while the restoration quality was judged on intraoral photographs. The restoration status with regard to margins, anatomy, and color was assessed using three quality scores (A = ideal, B = satisfactory, C = insufficient). Descriptive statistics were used to [...]

Reference

DIETSCHI, Didier, SPREAFICO, Roberto Carlo. Evidence-based concepts and procedures for bonded inlays and onlays. Part III. A case series with long-term clinical results and follow-up. *The International Journal of Esthetic Dentistry*, 2019, vol. 14, no. 2, p. 118-133

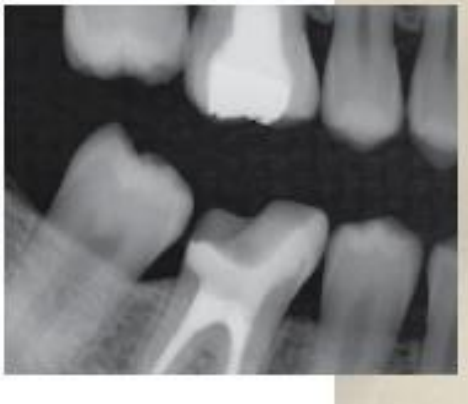
PMID : 31061993

# Deep Margin Elevation: A Paradigm Shift

**Pascal Magne,** DMD, PhD
Don and Sybil Harrington Professor of Esthetic Dentistry, Restorative Sciences, Ostrow School of Dentistry, University of Southern California, Los Angeles, California, USA.

**Roberto C. Spreafico,** DM, DMD
Private Practice, Milan, Italy.

Localized subgingival margins can complicate the use of indirect adhesive restorations (isolation, impression taking, and delivery) and subsequently hinder their durability and relationship with the periodontal tissues. This article proposes a technique involving placement of a modified Tofflemire matrix followed by immediate dentin sealing and coronal elevation of the deep margin to a supragingival position using a direct bonded composite resin base. The deep margin elevation technique may be a useful noninvasive alternative to surgical crown lengthening. This technique may also facilitate the placement of large direct composite resin restorations. The fundamental principles of deep margin elevation are presented. *(Am J Esthet Dent 2012;2:86–96.)*



Correspondence to: Dr Pascal Magne
Division of Restorative Sciences, Oral Health Center, Ostrow School of Dentistry of USC, 3151 S. Hoover St, Los Angeles, CA 90089-7792. Fax: 213-821-3324. Email: magne@usc.edu

# Evidence-based concepts and procedures for bonded inlays and onlays. Part I. Historical perspectives and clinical rationale for a biosubstitutive approach

**Didier Dietschi,** DMD, PhD, PD
Senior Lecturer, Department of Cariology and Endodontics, School of Dentistry, University of Geneva, Switzerland
Adjunct Professor, Department of Comprehensive Dentistry, Case Western Reserve University, Cleveland, Ohio
Private Education Center, The Geneva Smile Center, Geneva, Switzerland

**Roberto Spreafico,** MD, DMD
Private Practice, Busto-Arsizio, Italy
Private Education Center, The Geneva Smile Center, Geneva, Switzerland

Correspondence to: Dr Didier Dietschi, DMD, PhD, PD
School of Dentistry, Faculty of Medicine, University of Geneva, 19 rue Barthélémy Menn, 1205 Geneva, Switzerland.
E-mail: didier.dietschi@unige.ch

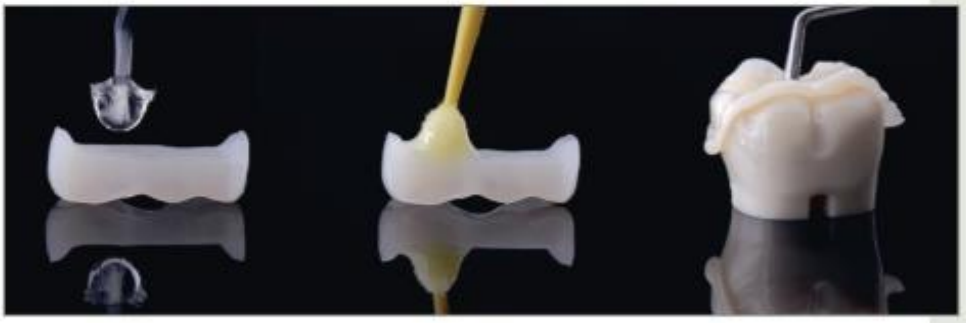
# Luting of inlays, onlays, and overlays with preheated restorative composite resin does not prevent seating accuracy

**Pascal Magne,** DMD, PhD, PD
The Don & Sybil Harrington Professor of Esthetic Dentistry, Division of Restorative Sciences, Herman Ostrow School of Dentistry, University of Southern California, Los Angeles, California, USA

**Mehrdad Razaghy,** DDS
Student, Herman Ostrow School of Dentistry, University of Southern California, Los Angeles, California, USA

**Marco Aurelio Carvalho,** DDS, MS, PhD
Department of Prosthodontics and Periodontology, University of Campinas, Piracicaba, Brazil

**Luciana Mara Soares,** DDS, MS
Private Practice, Campinas, Brazil



Correspondence to: Dr Luciana Mara Soares
Rua Germano Casellatto, 60, Santa Genebra II, Campinas, SP, 13084-776, Brazil.
Tel: +55 (19) 99645-7160; Email: soareslumara@gmail.com

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

# A comparative evaluation of the translucency of zirconias and lithium disilicate for monolithic restorations

Kosuke Harada, DDS, PhD,[a] Ariel J. Raigrodski, DMD, MS,[b] Kwok-Hung Chung, DDS, MS, PhD,[c] Brian D. Flinn, PhD,[d] Sami Dogan, DDS,[e] and Lloyd A. Mancl, PhD[f]

## INTRODUCTION

Lithium disilicate glass ceramic has more favorable mechanical properties compared with conventional dental porcelains and has excellent optical properties. Although, the mechanical properties of lithium disilicate are inferior compared with zirconia, it has been considered superior in terms of translucency. With its variety of translucency levels and shades, lithium disilicate can be fabricated as a monolithic restoration with surface characterization.[1,2] Therefore, lithium disilicate has been widely used for esthetic monolithic ceramic crowns.[3] However, results from clinical studies have demonstrated that these restorations have to be bonded if conservative tooth reduction of 1.0 to 1.5 mm or 1.5 to 2.0 mm is considered the ultimate clinical goal.[4-6]

## ABSTRACT

**Statement of problem.** Studies comparing the translucency of zirconias and lithium disilicates are limited.

**Purpose.** The purpose of this in vitro study was to measure the translucency of recently developed translucent zirconias and compare them with lithium disilicate.

**Material and methods.** Five types of zirconia, Prettau Anterior (Zirkonzahn GmbH), BruxZir (Glidewell Laboratories), Katana HT, Katana ST, and Katana UT (Kurary Noritake Dental Inc), and 1 type of lithium disilicate, e.max CAD LT (Ivoclar Vivadent AG), were assessed. Non-colored zirconia test specimens (n=5) were prepared as rectangles with dimensions of 15×10×0.5 and 15×10×1.0 mm. The shade of lithium disilicate was B1. A spectrophotometer (Evolution 300 UV-Vis) with an integrating sphere was used to evaluate the total transmittance of light as a percentage ($T_t$%) at a wavelength of 555 nm for comparison among groups. The Welch robust test for equality of means was used to compare group means ($\alpha$=.025) and post hoc pairwise comparisons among groups were performed with the Dunnett T3 method.

**Results.** For the 0.5 mm thickness groups, the $T_t$% was 31.90 ±0.49 for Prettau Anterior, 28.82 ±0.22 for BruxZir, 28.49 ±0.14 for Katana HT, 31.67 ±0.24 for Katana ST, 33.73 ±0.13 for Katana UT, and 40.32 ±0.25 for e-max CAD LT. Post hoc tests indicated that all groups were significantly different from each other, except for between BruxZir and Katana HT, and between Prettau Anterior and Katana ST. Katana UT was significantly more translucent than all other zirconias, and e-max CAD LT was significantly more translucent than all zirconias. For the 1.0 mm thickness groups, the Tt% was 22.58 ±0.41 for Prettau Anterior, 20.13 ±0.22 for BruxZir, 20.18 ±0.39 for Katana HT, 21.86 ±0.39 for Katana ST, 23.37 ±0.27 for Katana UT, and 27.05 ±0.56 for e-max CAD LT. Post hoc tests indicated that all materials were significantly different from each other, except for between BruxZir and Katana HT, and among Prettau Anterior, Katana ST and Katana UT which were significantly more translucent than all other zirconias and less translucent than e-max CAD LT.

**Conclusion.** At a thickness of 0.5 mm, Katana UT was significantly more translucent than all other zirconias, and e-max CAD LT was significantly more translucent than all zirconias. At a thickness of 1.0 mm, Prettau Anterior, Katana ST, and Katana UT were significantly more translucent than all other zirconias and less than e-max CAD LT. (J Prosthet Dent 2016;116:257-263)

[a]Visiting Lecturer, Department of Restorative Dentistry, School of Dentistry, University of Washington, Seattle, Wash; and Adjunct Lecturer, Department of Crown and Bridge, School of Life Dentistry at Tokyo, The Nippon Dental University, Tokyo, Japan.
[b]Professor, Department of Restorative Dentistry, School of Dentistry, University of Washington, Seattle, Wash.
[c]Professor, Department of Restorative Dentistry, School of Dentistry, University of Washington, Seattle, Wash.
[d]Research Associate Professor, Department of Materials Science and Engineering, University of Washington, Seattle, Wash.
[e]Assistant Professor, Department of Restorative Dentistry, School of Dentistry, University of Washington, Seattle, Wash.
[f]Research Associate Professor, Department of Oral Health Sciences, University of Washington, Seattle, Wash.

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

# Comparison of the mechanical properties of translucent zirconia and lithium disilicate

Sung Joon Kwon,[a] Nathaniel C. Lawson, DMD, PhD,[b] Edward E. McLaren, DDS, MDC,[c] Amir H. Nejat, DDS, MS,[d] and John O. Burgess, DDS, MS[e]

## ABSTRACT

**Statement of problem.** Three mol% yttria-stabilized tetragonal zirconia polycrystal (3Y-TZP) possesses excellent mechanical properties but is relatively opaque. Five mol% yttria-stabilized zirconia polycrystal (5Y-ZP) offers improved translucency, but many of its clinical properties have not been compared with those of 3Y-TZP and lithium disilicate.

**Purpose.** The purpose of this in vitro study was to compare the flexural strength, translucency parameter, bond strength, and enamel and material wear of 5Y-ZP (Katana UTML) with 3Y-TZP (Katana HT) and lithium disilicate (e.max CAD).

**Material and methods.** Flexural strength bars were sectioned (n=10, 25×4×2 mm), sintered or crystallized, polished, and fractured at 1 mm/min. Translucency specimens (1 mm thick) were fabricated (n=10). Their L*a*b* values were measured against a black-and-white background with a spectrophotometer, and $\Delta E_{00}$ was calculated. Zirconia bond strength specimens were airborne-particle abraded with 50 μm alumina followed by the application of a 10-methacryloxydecyl dihydrogen phosphate–containing primer (Clearfil Ceramic Primer). Lithium disilicate bond strength specimens were etched with 5% hydrofluoric acid followed by application of a silane-containing primer (Clearfil Ceramic Primer). A Tygon tube filled with resin cement (Panavia SA) was fixed to the surface of the ceramics and light-polymerized. After 1 day or 150 days of water storage, the resin cement was debonded in a macroshear test (n=10). The cusps of extracted human molars were isolated and mounted into the University of Alabama at Birmingham wear-testing device. Wear testing was performed with a 20-N load for 300 000 cycles in 33% glycerin. The volumetric wear of polished zirconia, lithium disilicate, and enamel were measured along with the wear of the opposing enamel cusps using a noncontact profilometer (n=8). The data were compared by ANOVA and Tukey-Kramer analysis (α=.05).

**Results.** No statistical difference was seen between the bond strengths ($P$=.155) or the opposing enamel wear ($P$=.533) of different ceramics. A statistically significant difference was seen between the flexural strength ($P$<.001), translucency parameter ($P$<.001), and wear ($P$<.001) of the materials. The flexural strength values (MPa) were 1194 ±111 (Katana HT), 688 ±159 (Katana UTML), and 450 ±53 (e.max LT). The translucency parameter values were 6.96 ±0.53 (Katana HT), 8.30 ±0.24 (Katana UTML), 9.28 ±0.36 (e.max LT), and 12.64 ±0.48 (e.max HT). Bond strength values (MPa) at 1 and 150 days were 34.22 ±5.14 and 28.37 ±6.03 (Katana HT), 35.04 ±5.69 and 25.03 ±6.44 (Katana UTML), and 35.50 ±3.45 and 22.32 ±3.45 (e.max LT). Material and enamel wear ($mm^3$) were 0 and 0.24 ±0.19 (Katana HT), 0 and 0.23 ±0.09 (Katana UTML), 0.28 ±0.13 and 0.31 ±0.10 (e.max CAD), and 0.09 ±0.03 and 0.31 ±0.14 (enamel).

**Conclusions.** 5Y-TZP has a flexural strength and translucency parameter between those of 3Y-TZP and lithium disilicate. Both the short-term and long-term bond strength of 5Y-ZP and 3Y-TZP was shown to be similar to lithium disilicate. 5Y-ZP demonstrated no measurable material wear and opposing enamel wear similar to that of all the other materials tested. (J Prosthet Dent 2018;120:132-7)

Presented at the American Association of Dental Research Annual Session, Los Angeles, Calif., March 2016. Supported partially by a grant from Kuraray.
[a]Predoctoral student, Department of Chemistry, University of Alabama at Birmingham, Birmingham, Ala.
[b]Assistant Professor, Department of Biomaterials, Clinical and Community Sciences, University of Alabama at Birmingham, Birmingham, Ala.
[c]Professor, Department of Biomaterials, Clinical and Community Sciences, University of Alabama at Birmingham, Birmingham, Ala.
[d]Resident, Department of Prosthodontics, Louisiana State University, New Orleans, La.
[e]Adjunct Professor, Department of Biomaterials, Clinical and Community Sciences, University of Alabama at Birmingham, Birmingham, Ala.

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

# Effect of different dental ceramic systems on the wear of human enamel: An in vitro study

Roya Zandparsa, DDS, MSc, DMD,[a] Rabie M. El Huni, BDS, MS,[b] Hiroshi Hirayama, DDS, DMD, MS,[c] and Marc I. Johnson, MBA[d]

## ABSTRACT

**Statement of problem.** The wear of tooth structure opposing different advanced dental ceramic systems requires investigation.

**Purpose.** The purpose of this in vitro study was to compare the wear of advanced ceramic systems against human enamel antagonists.

**Material and methods.** Four ceramic systems (IPS e.max Press, IPS e.max CAD, Noritake Super Porcelain EX-3, and LAVA Plus Zirconia) and 1 control group containing human enamel specimens were used in this study (n = 12). All specimens were fabricated as disks 11 mm in diameter and 3 mm thick. The mesiopalatal cusps of the maxillary third molars were prepared to serve as the enamel styluses. All specimens were embedded individually in 25 $mm^3$ autopolymerizing acrylic resin blocks. Wear was measured with a cyclic loading machine and a newly designed wear simulator. All enamel styluses (cusps) were scanned using the Activity 880 digital scanner (SmartOptics). Data from the base line and follow-up scans were collected and compared with Qualify 2012 3-dimensional (3D) and 2D digital inspection software (Geomagic), which aligned the models and detected the geometric changes and the wear caused by the antagonist specimen. One-way ANOVA was used to analyze the collected data.

**Results.** After 125 000 bidirectional loading cycles, the mean loss of opposing enamel volume for the enamel disks in the control group was 37.08 $\mu m^3$, the lowest mean value for IPS e.max Press system was 39.75 $\mu m^3$; 40.58 $\mu m^3$ for IPS e.max CAD; 45.08 $\mu m^3$ for Noritake Super Porcelain EX-3 system; and 48.66 $\mu m^3$ for the Lava Plus Zirconia system. No statically significant differences were found among the groups in opposing enamel volume loss ($P$=.225) or opposing enamel height loss ($P$=.149). In terms of opposing enamel height loss, Lava Plus Zirconia system showed the lowest mean value of 27.5 μm. The mean value for the IPS e.max CAD system was 27.91 μm; 29.08 μm for the control enamel; 33.25 μm for the IPS e.max Press system; and 34.75 μm for the Noritake Super Porcelain EX-3 system.

**Conclusions.** Within the limitations of this in vitro study, no differences were found in the linear and volumetric reduction of enamel cusps abraded against enamel disks and all other ceramic specimens. All ceramic systems exhibited high durability and were wear-friendly to opposing enamel. (J Prosthet Dent 2016;115:230-237)

The search for tooth-colored restorations with high strength, enhanced marginal integrity, and improved esthetics in the posterior region of the mouth has led to dental ceramics with improved physical and mechanical properties.[1-7] Ideally, loads placed on the occlusal surfaces of teeth should be kept at a level commensurate with normal physiologic wear and aging.[8] Compared with the mean annual occlusal wear of human tooth enamel (15-38 μm),[9] dental ceramics are considered wear-resistant and tend to damage the opposing enamel, the damage varies according to the ceramic material used.[9-12] The results of several studies have indicated that ceramic materials cause more wear on opposing enamel tooth structure than on cast gold alloy.[13-16] Variations in ceramic composition, microstructure, and fusing temperatures did

Support (materials) provided by Ivoclar Vivadent Inc and 3M ESPE presented at the 44th Annual Meeting of the American College of Prosthodontists, New Orleans, La, November 2014.
[a]Clinical Professor, Postgraduate Prosthodontics and Advanced Education in Esthetic and Operative Dentistry, Prosthodontic Division, Tufts University School of Dental Medicine, Boston, Mass.
[b]Former resident, Advanced Education in Implant Dentistry, Tufts University School of Dental Medicine, Boston, Mass.
[c]Professor, Tufts University School of Dental Medicine, Boston, Mass.
[d]President, Texture Technology Corporation, Hamilton, Mass.

DENTAL MATERIALS 29 (2013) 324–331

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/dema

# Fatigue resistance and crack propensity of large MOD composite resin restorations: Direct versus CAD/CAM inlays

*Silvana Batalha-Silva*[a], *Mauro Amaral Caldeira de Andrada*[a], *Hamilton Pires Maia*[a], *Pascal Magne*[b,*]

[a] *Department of Operative Dentistry, Federal University of Santa Catarina, Florianópolis, Brazil*
[b] *The Don and Sybil Harrington Chair in Esthetic Dentistry, Herman Ostrow School of Dentistry, University of Southern California, Los Angeles, USA*

ARTICLE INFO

*Article history:*
Received 23 February 2012
Received in revised form 1 July 2012
Accepted 15 November 2012

*Keywords:*
Composite resin
CAD/CAM
Fatigue resistance
Crack propensity
Shrinkage stress

ABSTRACT

*Objectives.* To assess the influence of material/technique selection (direct vs. CAD/CAM inlays) for large MOD composite adhesive restorations and its effect on the crack propensity and in vitro accelerated fatigue resistance.

*Methods.* A standardized MOD slot-type tooth preparation was applied to 32 extracted maxillary molars (5 mm depth and 5 mm bucco-palatal width) including immediately sealed dentin for the inlay group. Fifteen teeth were restored with direct composite resin restoration (Miris2) and 17 teeth received milled inlays using Paradigm MZ100 block in the CEREC machine. All inlays were adhesively luted with a light curing composite resin (Filtek Z100). Enamel shrinkage-induced cracks were tracked with photography and transillumination. Cyclic isometric chewing (5 Hz) was simulated, starting with a load of 200 N (5000 cycles), followed by stages of 400, 600, 800, 1000, 1200 and 1400 N at a maximum of 30,000 cycles each. Samples were loaded until fracture or to a maximum of 185,000 cycles.

*Results.* Teeth restored with the direct technique fractured at an average load of 1213 N and two of them withstood all loading cycles (survival = 13%); with inlays, the survival rate was 100%. Most failures with Miris2 occurred above the CEJ and were re-restorable (67%), but generated more shrinkage-induced cracks (47% of the specimen vs. 7% for inlays).

*Significance.* CAD/CAM MZ100 inlays increased the accelerated fatigue resistance and decreased the crack propensity of large MOD restorations when compared to direct restorations. While both restorative techniques yielded excellent fatigue results at physiological masticatory loads, CAD/CAM inlays seem more indicated for high-load patients.



## 1. Introduction

The longevity of dental restorations is influenced by multiple parameters such as material properties, patient's conduct and dentist's skills [1,2]. Polymerization shrinkage stress of composite resin restorations is one of the major problems related to direct techniques, especially in large and high C-factor defects [3,4]. Contraction stress challenges the dentin–resin hybrid layer and may result in gap formation and/or decreased dentin bond strength [5–7]. On the other hand, when using strong adhesives and achievingtotal

* *Corresponding author at:* The Herman Ostrow School of Dentistry – Oral Health Center, 3151 S. Hoover St., Los Angeles, CA 90089-7792, USA. Tel.: +1 213 740 4239; fax: +1 213 821 5324.
E-mail address: magne@usc.edu (P. Magne).
0109-5641/$ – see front matter © 2012 Academy of Dental Materials. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.dental.2012.11.013

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

# Comparison of dimensional accuracy of conventionally and digitally manufactured intracoronal restorations

Reza Eftekhar Ashtiani, DDS, MS,[a] Leila Nasiri Khanlar, DDS, MS,[b] Minoo Mahshid, DDS, MS,[c] and Alireza Moshaverinia, DDS, MS, PhD[d]

## ABSTRACT

**Statement of problem.** Advances have been made in digital dentistry for the fabrication of dental prostheses, but evidence regarding the efficacy of digital techniques for the fabrication of intracoronal restorations is lacking.

**Purpose.** The purpose of this in vitro study was to compare the dimensional accuracy of intracoronal restorations fabricated with digital and conventional techniques.

**Material and methods.** A sound mandibular molar tooth received a standard onlay preparation, and onlays were fabricated with 1 of 3 fabrication techniques. In group CC, the onlays were made after conventional impression and conventional fabrication of a resin pattern. In group CP, the onlays were made after conventional impression and 3-dimensional (3D) printing of the pattern. In group IP, the onlays were made after intraoral scanning, and 3D printing produced the resin pattern. Ten specimens in each group (N=30) were evaluated. Glass-ceramic restorations were fabricated using the press technique. The replica technique was used to assess the marginal fit. Each replica was assessed at 8 points. One-way ANOVA was used to compare the marginal discrepancy among the 3 groups. The Tukey honest significant differences test was applied for pairwise comparisons of the groups ($\alpha$=.05).

**Results.** No significant differences were noted in the marginal discrepancy at the gingival margin among the 3 groups ($P$=.342), but significant differences were noted among the 3 groups in the pulpal ($P$=.025) and lingual ($P$=.031) areas. Comparison of the absolute discrepancy among the 3 groups revealed that only groups CC and CP were significantly different ($P$=.020) from each other.

**Conclusions.** Within the limitations of this in vitro study, the conventional method yielded more accuracy than the 3D printing method, and no differences were found between the methods which used the 3D printer (groups CP and IP). (J Prosthet Dent 2018;119:233-238)

The successful fabrication of dental prostheses in general and intracoronal restorations in particular depends on the expertise, experience, and skills of the dental clinicians and laboratory technicians. Digital dentistry enables the direct fabrication of dental restorations by using digitized models. Digital methods decrease the risk of human error as well as the treatment cost. These methods enable faster fabrication of more precise restorations.[1] Presently, rapid prototyping (RP) techniques are promising alternatives for fabrication of dental prostheses.[1]

The ultimate goal in the fabrication of restorations is to preserve residual tooth structure and obtain an accurate fit between the restoration and the remaining tooth structure. Internal and marginal misfit and the presence of discrepancies adversely affect the longevity of indirect restorations.[2-4] Ill-fitting restoration margins increase plaque retention[5,6] and result in the irritation and traumatization of the gingiva and development of secondary caries.[7-9] The internal fit is important especially for ceramic restorations because marginal and internal fittings of ceramic restorations are important determinants of clinical longevity.[10] Well-fitting margins allow for better removal of resin cement and better preservation of periodontal health.[3,4,11,12]

Supported by the School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[a]Assistant Professor and Chair, School of Dental Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[b]Assistant Professor, Operative Dentistry Department, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[c]Professor, Department of Prosthodontics, Dental School, Shahid Beheshti University of Medical Science, Tehran, Iran.
[d]Assistant Professor, Division of Advanced Prosthodontics, UCLA School of Dentistry, Los Angeles, Calif.

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

# Marginal and internal fit of pressed lithium disilicate inlays fabricated with milling, 3D printing, and conventional technologies

Foudda R. Homsy, DCD, DES,[a] Mutlu Özcan, Dr Med Dent, PhD,[b] Marwan Khoury,[c] and Zeina A. K. Majzoub, DCD, DMD, MScD[d]

## ABSTRACT

**Statement of problem.** The subtractive and additive computer-aided design and computer-aided manufacturing (CAD-CAM) of lithium disilicate partial coverage restorations is poorly documented.

**Purpose.** The purpose of this in vitro study was to compare the marginal and internal fit accuracy of lithium disilicate glass-ceramic inlays fabricated with conventional, milled, and 3-dimensional (3D) printed wax patterns.

**Material and methods.** A dentoform mandibular first molar was prepared for a mesio-occlusal ceramic inlay. Five groups of 15 inlays were obtained through conventional impression and manual wax pattern (group CICW); conventional impression, laboratory scanning of the stone die, CAD-CAM milled wax blanks (group CIDW) or 3D printed wax patterns (group CI3DW); and scanning of the master preparation with intraoral scanner and CAD-CAM milled (group DSDW) or 3D printed wax patterns (group DS3DW). The same design was used to produce the wax patterns in the last 4 groups. The replica technique was used to measure marginal and internal adaptation by using stereomicroscopy. Mixed-model ANOVA was used to assess differences according to the groups and discrepancy location ($\alpha$=.05).

**Results.** Group DSDW showed the smallest marginal discrepancy (24.3 μm) compared with those of groups CICW (45.1 μm), CIDW (33.7 μm), CI3DW (39.8 μm), and DS3DW (39.7 μm) ($P$<.001). No statistically significant differences were detected among groups CICW, CIDW, CI3DW, and DS3DW relative to the marginal discrepancy. The internal discrepancy was significantly larger than the marginal discrepancy within all groups ($P$<.001).

**Conclusions.** Lithium disilicate glass-ceramic inlays produced from digital scans and subtractive milling of wax patterns resulted in better marginal and internal fit accuracy than either conventional impression/fabrication or additive 3D manufacturing. Three-dimensional printed wax patterns yielded fit values similar to those of the conventionally waxed inlays. (J Prosthet Dent 2018;119:783-90)

Synthetic lithium disilicate glass-matrix ceramics (IPS e.max) are widely used in the fabrication of tooth- and implant-supported prostheses because of their excellent esthetics and mechanical properties.[1,2] IPS e.max lithium disilicate (Ivoclar Vivadent AG) restorations can be fabricated by using either computer-aided-designed and computer-aided-manufactured (CAD-CAM) milling procedures (IPS e.max CAD) or the lost-wax techniques (IPS e.max Press).[3] The patterns used to generate e.max Press restorations are conventionally fabricated with wax shaped by laboratory technicians. Despite the advantages of convenient laboratory manipulation and precise shaping,[4] this approach has inherent drawbacks related to thermal sensitivity and the high coefficient of the thermal expansion of wax.[4] This method is also time-consuming and technique-sensitive.[5,6]

Digital dentistry allows fabrication of patterns with more advanced technologies such as subtractive milling/machining with CAD-CAM systems or additive

Ivoclar Vivadent AG provided part of the IPS e.max Press and CAD materials. Supported in part by the National Council for Scientific Research, Beirut, Lebanon.
[a]Chief of Clinical Services, Prosthodontics Department, School of Dentistry, Lebanese University, Hadath, Lebanon.
[b]Professor, Dental Materials Unit, University of Zurich, Zürich, Switzerland.
[c]Laboratory Technician, Zirconnet Dental Laboratory, Zalka, Beirut, Lebanon.
[d]Professor, Periodontics Department, School of Dentistry, Lebanese University, Hadath, Lebanon.

THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL RESEARCH

# Comparison of 16.9-year survival of pressed acid etched e.max lithium disilicate glass ceramic complete and partial coverage restorations in posterior teeth: Performance and outcomes as a function of tooth position, age, sex, and thickness of ceramic material

Kenneth A. Malament, DDS, MScD,[a] Mariam Margvelashvili-Malament, DMD, MSc, PhD,[b] Zuhair S. Natto, BDS, MPH, MSc, DrPH,[c] Van Thompson, PhD, DDS,[d] Dianne Rekow, PhD, DDS,[e] and Wael Att, DDS, Dr med dent, PhD[f]

## ABSTRACT

**Statement of problem.** Long-term clinical data are lacking on the comparison of the survival of adhesively luted pressed e.max lithium disilicate glass ceramic complete and partial coverage restorations in posterior dentitions and the effect that different technical and clinical variables have on their survival.

**Purpose.** The purpose of this clinical study was to examine and compare the 16.9-year survival of posterior pressed e.max lithium disilicate glass ceramic complete and partial coverage restorations and associated clinical parameters on the outcome.

**Material and methods.** Patients requiring either single-unit posterior defect-specific partial coverage or complete coverage restorations were recruited in a clinical private practice. The participants were offered the options of direct restorations, partial coverage cast gold, or glass ceramic (lithium disilicate) restorations. Those requiring complete coverage restorations were given the options of complete cast gold, metal-ceramic, or glass ceramic restorations. Only participants who chose glass ceramic partial and complete coverage restorations were included in the study. The overall survival of the glass ceramic restorations was assessed by the clinical factors determined at recall. The effect of various clinical parameters (type of restoration, dental arch, tooth position in the dental arch, age and sex of participant, and ceramic thickness) was evaluated by using Kaplan-Meier survival curves to account for attrition bias and other reasons for failure. The statistical significance of differences between parameters was determined using the log rank test ($\alpha$=.05).

**Results.** A total of 738 participants requiring 2392 lithium disilicate restorations in posterior teeth were evaluated. The mean age of the participants at the time of restoration placement was 62 (range: 20-99 years, 302 men and 436 women). Of 2392 units, 1782 were complete and 610 were partial coverage restorations. A total of 22 failures (bulk fracture or large chip) requiring replacement were recorded with the average time to failure 3.5 (0.02-7.9) years. The total time at risk computed for these units was 13227.9 years, providing an estimated failure risk of 0.17% per year. The 16.9-year estimated cumulative survival was 96.49%. The estimated cumulative survival of posterior complete (n=1782) and posterior partial coverage restorations (n=610) was 96.75% at 10.5 years and 95.27% at 16.9 years ($P<.05$). Of the 22, 16 failures were recorded for the complete coverage restorations. The total time at risk for these restorations was 10144.5 years, providing an estimated risk of 0.16 per year. The other 6 failures recorded occurred for the partial coverage restorations. The total time at risk for these restorations was 3083.5 years, providing an estimated risk of 0.19% per year. No statistically significant difference was found in the survival of posterior complete and partial coverage restorations among men and women, different age groups, or posterior tooth position in the dental arch ($P>.05$). The thickness of the restoration also had no influence on the survival of glass ceramic posterior restorations ($P>.05$).

**Conclusions.** Pressed e.max lithium disilicate complete and partial coverage restorations showed high survival rates in posterior teeth over a 16.9-year period, with an overall failure rate of 0.17% per year. Risk of failure at any age was low for both men and women. No statistically significant difference was found in the survival of complete and partial coverage restorations, and none of the confounding variables, including the thickness of the restoration, appeared to have a significant effect on survival. (J Prosthet Dent 2020;■:■-■)

[a]Clinical Professor, Department of Prosthodontics, Tufts University School of Dental Medicine, Boston, Mass.
[b]Assistant Professor, Department of Prosthodontics, Tufts University School of Dental Medicine, Boston, Mass.
[c]Assistant Professor, Department of Dental Public Health, Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia; Adjunct Assistant Professor, Department of Periodontology, Tufts University School of Dental Medicine, Boston, Mass.
[d]Professor Emeritus, Faculty of Dentistry, Oral and Craniofacial Sciences, King's College London, London, UK.
[e]Professor Emeritus, Faculty of Dentistry, Oral and Craniofacial Sciences, King's College London, London, UK.
[f]Professor and Chair, Department of Prosthodontics, Tufts University School of Dental Medicine, Boston, Mass.

INTERNATIONAL ENDODONTIC JOURNAL

doi:10.1111/iej.12242

# The survival of indirect composite resin onlays for the restoration of root filled teeth: a retrospective medium-term study

**V. Chrepa[1], I. Konstantinidis[2], G. A. Kotsakis[3] & M. E. Mitsias[4,5,6]**

[1]AdvancedEducation Program in Endodontics, UTHSCSA, San Antonio, TX, USA; [2]Department of Prosthetic Dentistry, University Hospital Carl Gustav Carus, Technical University Dresden, Dresden, Germany; [3]Advanced Education Program in Periodontology, University of Minnesota, Minneapolis, MN, USA; [4]Private Practice, Athens, Greece; [5]Departments of Periodontology and Implant Dentistry, New York University, New York, NY, USA; and [6]Department of Prosthodontics, University of Kiel, Kiel, Germany

## Abstract

**Chrepa V, Konstantinidis I, Kotsakis GA, Mitsias ME.** The survival of indirect composite resin onlays for the restoration of root filled teeth: a retrospective medium-term study. *International Endodontic Journal*, **47**, 967–973, 2014.

**Aim** To investigate the outcomes of root filled posterior teeth restored with indirect composite resin onlays using tooth and restoration survival as well as the quality of restoration as outcome measures.

**Methodology** All patients were treated by the same clinician with indirect composite onlays for the restoration of root filled posterior teeth between January 2008 and February 2010 in a single clinic setting. Primary root canal treatment was performed and onlays fabricated with the indirect method using indirect composite resin. Patients were seen every 4–6 months for maintenance visits according to standard clinic protocols and each patient's individualized maintenance schedule. Tooth and restoration survival were calculated, and the onlays were evaluated in accordance with the modified US Public Health Service (USPHS) criteria.

**Results** Thirty-one premolars and one hundred and fifty-eight molars ($n = 189$) of 153 patients were included. The observation period ranged from 24 to 52 months with a median follow-up time of 37 months. Tooth survival was found to be 100%, whilst the restoration survival was 96.8% and the functional restoration survival 98.9% at the end of the follow-up period. According to modified USPHS criteria, the A rating had a range of 83.1–100% for all evaluation criteria.

**Conclusions** Onlay restorations fabricated with indirect resin can be a viable option for the restoration of root filled teeth.

**Keywords:** composite resin onlays, endodontic therapy, endodontically treated teeth, onlay restoration, survival rate.

*Received 2 January 2013; accepted 1 January 2014*

## Introduction

Following root canal treatment, qualitative and quantitative alterations occur at the remaining tooth structure (Dietschi *et al.* 2011). Irrigants such as sodium hypochlorite (NaOCl) and chelators such as ethylenediamine tetra-acetic acid (EDTA), commonly used in root canal treatment, have been found to interact with the organic and mineral dentine components (Patterson 1963, Oliveira *et al.* 2007, Aranda-Garcia *et al.* 2013). These qualitative changes are likely to lead to a reduction in tooth strength after root canal treatment.

With respect to quantitative changes, the percentage of loss in tooth structure seems to be a major

Correspondence: Vanessa Chrepa, DDS, Resident, Advanced Education Program in Endodontics, UTHSCSA, 7703 Floyd Curl, San Antonio, TX 78229, USA (Tel.: +16513959491; fax: +12105673389; e-mail: chrepa@uthscsa.edu).