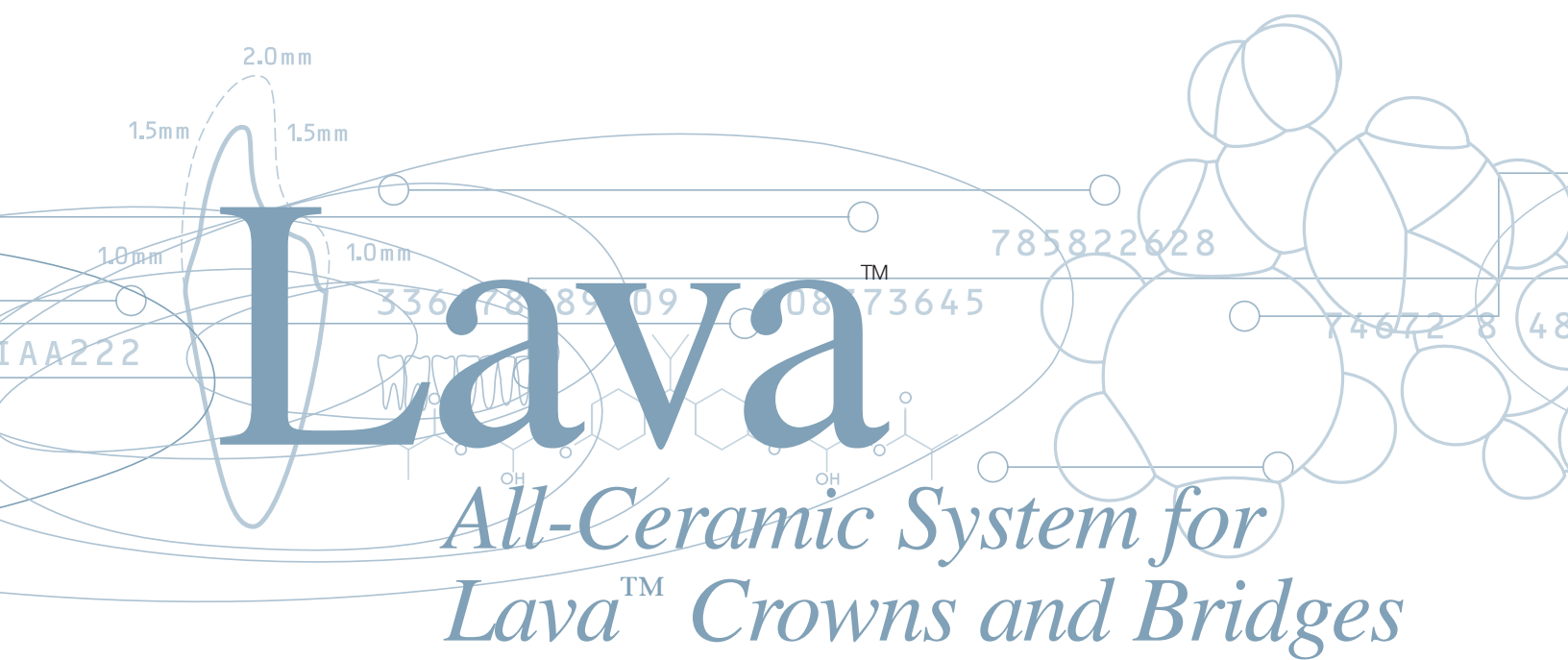


**3M** ESPE

A collection of scientific results



The graphic features the word "Lava" in a large, bold, blue serif font. Below it, the text "All-Ceramic System for Lava<sup>TM</sup> Crowns and Bridges" is written in a smaller, blue, italicized serif font. The background is a light blue and white technical illustration. It includes a cross-section of a crown with dimensions: 2.0mm at the top, 1.5mm on the sides, and 1.0mm at the base. To the right, there is a cluster of overlapping circles representing a ceramic microstructure. Various alphanumeric codes are scattered throughout the graphic, including "IAA222", "336788909", "0873645", "785822628", and "74672 8 48".

**Lava**<sup>TM</sup>

*All-Ceramic System for  
Lava<sup>TM</sup> Crowns and Bridges*

78th IADR / AADR / CADR General Session and Exhibition  
Washington, DC, USA, April 2000

79th AADR/CADR General Session and Exhibition  
Chicago, IL, USA, March 2001

79th IADR Annual Meeting  
Chiba, Japan, June 2001

IADR/BSDR/CED  
Cardiff, UK, September, 2002

AADR/CADR Annual Meeting  
San Antonio, TX, USA, March, 2003

81st IADR Meeting  
Göteborg, Sweden, June, 2003

82st IADR Meeting  
Honolulu, Hawaii, USA, March, 2004

CED/NOF/ID Joint Meeting  
Istanbul, Turkey, August 2004

Dear Reader,

With the introduction of Lava™ All-Ceramic System for Lava Crowns and Bridges in 2001, 3M ESPE has made a substantial contribution to the exciting and steadily increasing market of all-ceramic dentistry and CAD/CAM technology. Since then the outstanding material properties of the Lava™ ceramic (Y-TZP framework and the overlay veneering porcelain) and the technological advantages of the Lava system have convinced the dental profession. Many well-known universities and scientific institutions have performed in vitro and in vivo studies showing excellent mechanical and optical characteristics of Lava Crowns and Bridges as well as very good clinical performance.

In this issue we have summarized the most important results from in vitro and in vivo studies which have been presented since 2000 on international conferences.

We very much hope the clinical results presented in this booklet will serve as a valuable source of information and as a basis for further discussion. Please feel free to contact us any time.

Yours sincerely,



Dr. Anke Behrens  
Scientific Affairs Manager  
3M ESPE AG  
ESPE Platz  
82229 Seefeld



Dr. Berthold Reusch  
Technical Marketing Manager  
3M ESPE AG  
ESPE Platz  
82229 Seefeld

### Lava™ All-Ceramic System for Lava™ Crowns and Bridges

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# 2910

### Material Properties of All Ceramic Zirconia Prostheses

H. HAUPTMANN\*, D. SUTTOR, S. FRANK, H. HOESCHELER, 3M ESPE AG,  
82229 Seefeld, Germany

Yttria stabilized tetragonal zirconia ( $ZrO_2$ ) is currently investigated as a potential candidate for high performance all ceramic dental restorations due to its outstanding mechanical properties, its aesthetic appearance and its proven biocompatibility. In combination with suitable CAD/CAM systems and optical scanner devices precision fit prostheses can be realized, starting from conventional plaster models. As part of this ongoing work, a material data profile for the zirconia used has been established, including data on mechanical properties such as strength, reliability, toughness and subcritical crack growth (i.e. lifetime prediction), optical properties such as opacity and venerability. The material used was a 3 mole %  $Y_2O_3$  doped zirconia, yielding a predominantly tetragonal fine grained microstructure. Test bars were measured in 3-pt. bending (15/30 mm setup, test bars 3\*4\*35 mm), which were also used for fracture toughness measurements (resistance to crack propagation), using a modified indentation technique. Reliability (failure probability as a function of load) was determined using well established Weibull statistics as common in the ceramics field, subcritical crack growth by a dynamic loading method. Lifetime prediction (in vitro) was made based on Weibull and crack growth data. Opacity was measured as a function of sample thickness using DIN procedures (DIN 53146). 3-pt bending strength ( $\sigma_0$ ) was determined to be 930 MPa with a Weibull modulus (m) of 9.8. Fracture toughness ( $K_{Ic}$ ) was 5 MPa m<sup>1/2</sup>. Average fracture force as evaluated on simple bridge designs (3 units) was 1650 N connector cross section of 7.8 mm<sup>2</sup>. The subcritical crack growth parameter (n) was 50, indicating minor susceptibility to slow crack growth. Opacity of dense materials (> 99% TD) was 85% (1.5 mm) 65% (0.5 mm), respectively. Preliminary lifetime predictions showed a failure rate of  $\leq 2\%$  after 5 years at a load of 450 MPa. The material was readily venerable with conventional systems without cracks or chipping at the interface.

**Aim of the Study:** The 3M™ ESPE™ Lava™ zirconium oxide ceramic was evaluated with regard to all relevant dental ceramic properties and a preliminary lifetime prediction was deduced.

**Result of the Study:** The 3M™ ESPE™ Lava™ zirconium oxide material shows outstanding mechanical and optical properties for the use as dental restoration material. Moreover, due to the very positive lifetime prediction, the fabrication of posterior bridges with 3M™ ESPE™ Lava™ zirconium oxide material is possible.

### 0243

#### Fracture Strength of Colored versus Uncolored Zirconia Specimens

A. BEHRENS, B. REUSCH, and H. HAUPTMANN, 3M ESPE AG, Seefeld, Germany

**Objectives:** The objective of this study was to show that the fracture strength of the Y-TZP core material Lava (3M ESPE) is not effected by staining the Zirconia core material with Lava shading liquid. Many in vitro studies in recent years with Yttrium oxide stabilized Zirconia (Y-TZP) proved its superior material properties especially concerning strength and long-term stability as well as outstanding optical properties allowing high aesthetic results. However, by dying the Zirconia core material the aesthetic of the overall restoration can considerably be improved by avoiding white margins. Additionally, the tooth preparation can be designed even less minimal invasive due to the advantage that an opaque layer can be omitted. The challenge is to ensure the same strength of the stained Zirconia material.

**Methods:** In a biaxial bending test (punch on three balls) the fracture strength and Weibull parameters of Y-TZP specimens differently colored with shading liquid were determined. Uncolored specimens of Y-TZP served as control. The specimen diameters were 19 mm and the thickness 1.5 mm. The outer diameter circle measured 14 mm, whereas the loading punch had a diameter of 3.5 mm. For each color and control respectively 10 to 15 specimens were tested.

#### Results:

Shade	Fracture Strength (MPa)	Weibull Modulus
Uncolored Y-TZP	1115	12.7
Color FS1	1273	15.6
Color FS3	1034	11.6
Color FS4	1045	14
Color FS5	1182	10

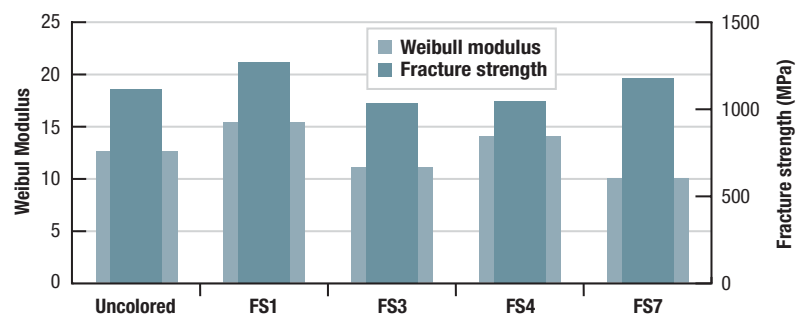
There is no significant reduction of the fracture strength and the Weibull modulus between the uncolored and stained core material. The values of the Weibull modulus stay above  $m = 10$  indicating a low strength variation.

**Conclusions:** There is no loss of long term stability by staining the restorations, but a high aesthetic outcome which is further underlined by clinical cases.

**Aim of the Study:** The aim of this study was to show that the fracture strength of Y-TZP 3M™ ESPE™ Lava™ zirconium oxide is not effected by staining the material.

**Result of the Study:** There is no significant reduction of the fracture strength and Weibull modulus of Y-TZP Lava™ zirconium oxide by staining the material.

Fracture Strength of Colored versus Uncolored Zirconia Specimens



## 174

### Fracture Strength of Tooth Colored Posterior Fixed Partial Dentures

M. ROSENTRITT\*, M. BEHR, R. LAND, S. KLEINMAYER, G. HANDEL,  
 Department of Prosthetic Dentistry, University Clinics, Regensburg, Germany

The aim of this in-vitro study was to determine the fracture strength of adhesively luted tooth colored fixed partial dentures (FPD). 64 human molars were inserted in PMMA resin to simulate three-unit (10 mm) oral situation. The roots of the teeth were covered with an about 1mm thick layer of polyether to simulate the periodontium. 8 bridges of each series were made of A) InCeram (Vita, G), B) Empress 2 (Ivoclar, FL), C) CAD/CAM Lava (3M ESPE, G) and D) exper. design of fiber-reinforced composite and ceramic (Vectris-Empress 2, Ivoclar, FL). After thermal cycling and mechanical loading (TCML; 6000 thermal cycles [5°C/55°C], 1.2x10<sup>6</sup> mastication cycles [50 N]) fracture strengths (UTM 1446; Zwick; v = 1 mm/min) of 8 FPDs of each series were determined. Statistics: One-Way-Anova (p = 0.05).

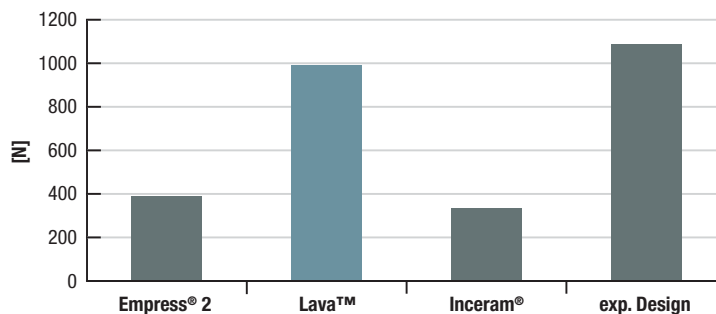
Fracture force [N]	Empress®2	Lava™	Inceram®	exp. Design
median	387	992	334	1087
25% percentile	330	815	315	968
75% percentile	445	1596	673	1215

In comparison to Lava and exp. FPDs the InCeram and Empress2 restorations showed significantly lower fracture strength values. No differences could be found between Empress2 and InCeram, and between Lava and exp. Design. The fracture values are located at a limit where clinical application seems promising. This study was supported by 3M ESPE, Germany.

**Aim of the Study:** The aim of this in-vitro study was to determine the fracture strength of adhesively luted tooth colored fixed partial dentures (FPD).

**Result of the Study:** In comparison to 3M™ ESPE™ Lava™ zirconium oxide the InCeram® and Empress®2 restorations showed significantly lower fracture strength values after thermal cycling and mechanical loading.

Fracture strength after thermal cycling & mechanical loading



# 173

### In-vitro-Investigations on the Fracture Strength of All-Ceramic Posterior Bridges of ZrO<sub>2</sub>-Ceramic

P. ROUNTREE\*, F. NOTHDURFT, P. POSPIECH, Dept. of Prosthodontics, Ludwig-Maximilians-University of Munich, Germany

All-ceramic bridges for the posterior region have been limited to the replacement of premolars due to the low tensile strength and fracture toughness of the available ceramic materials. However, with the introduction of new high-strength ceramic systems utilizing zircon-dioxide as the core-material, three- and four-unit-bridges should be possible. The aim of this in-vitro study was to investigate the fracture strength of three and four-unit-bridges made from zircon-dioxide ceca-mi (Lava/3M ESPE). In addition, the influence of artificial aging on the fracture strength of these bridges was tested.

**Material and Methods:** In total 32 models with identical preparation designs (0.8 mm chamfer) and resilient abutments were fabricated for two different situations: 1. missing lower first molar (three-unit); 2. missing lower second premolar and first molar (four-unit). The models were divided into four groups (table). Veneered zircon-dioxide bridges were fabricated according to the manufacturer's instructions. Core-dimensions and veneer-thickness were the same in all cases. 24 hours after cementation with Ketac-Cem, 8 bridges from each situation were artificially aged via a computer-controlled artificial-mouth (1.2 million cycles with 50 N) and simultaneously a thermocycling process (10,000 cycles) was performed between 5 and 55°C with a dwelling time of 30 seconds. The fracture strength was tested by static loading of the bridges in the center of the pontics under an angle of 90°. Statistical analysis was performed using Mann-Withney-U-Test.

**Results:** The four-unit-bridges exhibited a significantly lower fracture strength in comparison to the three-unit-bridges. Artificial aging significantly lowered the fracture strength of the three-unit-bridges, whereas the fracture strength of the four-unit-bridges was not affected.

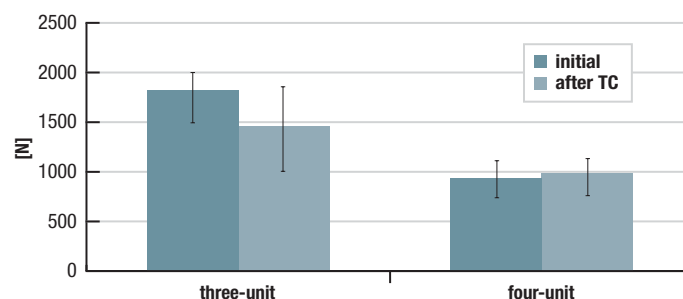
**Conclusion:** The fracture strength of the three-unit-bridges is adequate to justify their use in the posterior region, however, further investigations on the four-unit-bridges should be conducted before a general recommendation for their use can be made.

Group	Span-width	Chewing simulation	Fracture strength (mean/standdev.)
1	Molar	No	1816.9 N / 234.0
2	Molar	Yes	1457.6 N / 407.3
3	Premolar and molar	No	930.3 N / 212.5
4	Premolar and molar	Yes	978.5 N / 245.2

**Aim of the Study:** The aim of this in-vitro study was to investigate the influence of artificial aging on the fracture strength of 3- and 4-unit posterior 3M™ ESPE™ Lava™ bridges out of zirconium dioxide as core material.

**Result of the Study:** The fracture strength of 3-unit and 4-unit bridges is sufficiently high for their use in the posterior region, even after thermocycling.

**Fracture strength**



# 910

### Fracture Resistance of Posterior All Ceramic Zirconia Bridges

D. SUTTOR\*, H. HAUPTMANN, S. FRANK, S. HOESCHELER, 3M ESPE AG, Seefeld, Germany, P. POSPIECH, LM University of Munich, Munich, Germany

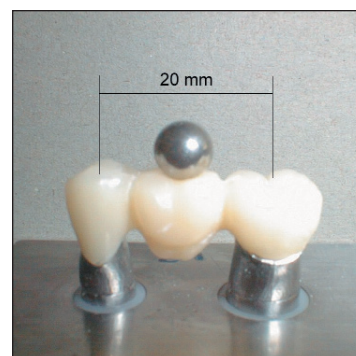
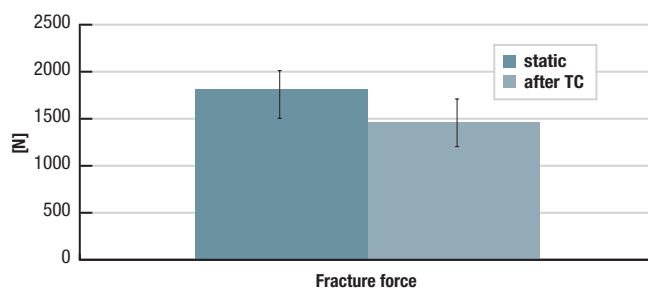
New all-ceramic restorations for posterior bridges, based on CAD/CAM technologies and polycrystalline ceramics, are currently investigated due to their outstanding physical properties. The aim of this study was, to compare the static and fatigue fracture resistance of 3-unit posterior bridges (45-47) made with the Lava-System. Lava is a new all-ceramic system using CAD/CAM-manufactured zirconia frameworks. In total 16 identical frameworks with two posterior resilient supported metal-dies were fabricated. Cross section of the connector area was 11 mm<sup>2</sup>, coping wall thickness 0.8 mm and the span width 20 mm. All bridges were veneered with a veneer ceramic specially developed for zirconia and cemented with Ketac Cem® (3M ESPE). The bridges were divided into 2 groups. The static fracture strength of 8 bridges was tested in an universal testing machine (Instron, MT, USA). The load was applied perpendicular at the centre of the pontic until complete fracture occurred. For the fatigue tests 8 bridges were cycled at 50 N over 1,200,000 cycles using a mastication and thermocycling (5°/55°) simulator (Willytec, Munich, Germany). The samples were then subsequently tested according to the static test setup until complete fracture occurred. The data of the static fracture strength (non-cycled) is comparable to other values of zirconia frameworks (Tinschert et al. DZZ 2000; 55:610-616). However, there was a significant difference between the cycled and non-cycled samples (pairwise t-test, 95% confidence level). This investigation showed, that although a strength reduction of approximately 20% between as received and fatigued samples is observed, the overall strength level of zirconia is sufficient for at least 3-unit posterior frameworks.

Fracture force [N]	Mean	SD
Static	1816	288
Cycled	1457	265

**Aim of the Study:** The aim of this study was to compare the initial static and fatigue fracture resistance of 3-unit all ceramic posterior 3M™ ESPE™ Lava™ bridges based on zirconium oxide and veneered with LavaCeram.

**Result of the Study:** Fatigue leads to a strength reduction, but the overall strength level of Lava™ bridges is still very high for the use in the posterior region.

### Fracture strength



### 0723

**Investigation of Connector Cross-sections for 4-unit Zirconia Oxide Bridges**  
 H. HAUPTMANN, and B. REUSCH, 3M ESPE AG, Seefeld, Germany

**Objectives:** To achieve high aesthetic results and to create enough space for soft tissue management connectors should be kept as small as possible. Mechanical properties of frame ceramics could limit the minimal value of cross sections due to the fact that bite forces up to 1000 N in cases of bruxism have been described in literature. The outstanding mechanical properties of zirconia like Lava™ frame (3M ESPE) offers new opportunities for high loaded and highly aesthetically designed posterior bridges. The aim of this study was to determine the bending strength of different connector cross sections in a standardized posterior 4 unit bridge situation.

**Methods:** The experimental set-up follows the suggestions described by P. Pospiech et al [JDentRes 79IADR Abstracts 2000/1014]. Series with 10 samples of a 4 unit bridge (2 units between 2 abutments) were cemented on flexible embedded stainless steel stumps. The dimension of the 3 connectors per bridge was altered between 9 mm<sup>2</sup> and 13 mm<sup>2</sup>, and the shape was varied. An analytical evaluation of the Weibull parameters with the maximum likelihood method was used.

**Results:** Table listing the Weibull strength  $\sigma$  and Weibull modulus  $m$  for circularly shaped connectors.

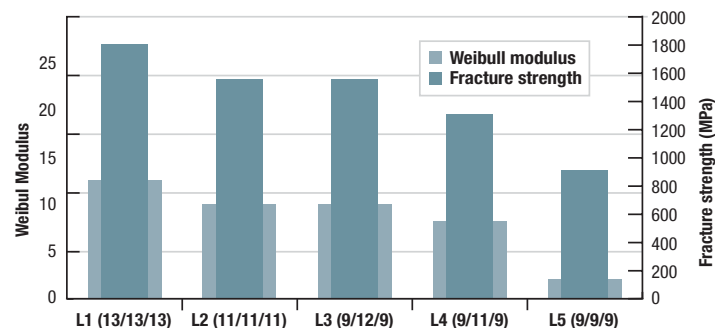
Serial	Connector Dim. [mm <sup>2</sup> ]	$\sigma$ [N]	Weibull modulus $m$
L1	13/13/13	1801	10.8
L2	11/11/11	1558	9.1
L3	9/12/9	1554	9.2
L4	9/11/9	1311	7.7
L5	9/9/9	912	1.9

**Conclusions:** A connector cross section of 16 mm<sup>2</sup> in minimum was recommended by some glass ceramic manufacturers for a posterior 3 unit bridge. Zirconia overcomes these limiting factors both mechanically and aesthetically; 4 unit bridges are now possible. The results shown allow us to predict the life time of the frame and give us the database for clinical studies.

**Aim of the Study:** Connector cross sections of bridges should be as small as possible due to aesthetic and functional reasons, but is often limited by the mechanical properties of the materials used. Some glass ceramics demand a connector cross section of 16 mm<sup>2</sup>. The aim of this study was to obtain information about the stability of different connector cross sections for Lava bridges out of zirconium oxide.

**Result of the Study:** Based on the results for 4-unit 3M™ ESPE™ Lava™ bridges out of zirconium oxide a connector cross section of 9/12/9 mm<sup>2</sup> is recommended for prosterior bridges optimizing aesthetic as well as functional demands.

**Weibull Strength dependent on Connector Cross-sections**



### 998

#### Fracture Strength of All-Ceramic Anterior Fixed Partial Dentures

K. LUDWIG\*, M. KERN, S. KLOPFER, Christian-Albrechts University at Kiel, Germany

The clinical success of all-ceramic restorations depends on the fatigue strength of the used ceramics. New systems with high fracture toughness are recommended to fabricate 3-unit fixed partial dentures (FPDs). The aim of this study was to compare the static and fatigue fracture strength of anterior FPDs made from Lava (3M ESPE, Germany) and Empress 2 (Ivoclar, FL). Lava is a new all-ceramic system using CAD/CAM-manufactured zirconia frameworks veneered with Lava Ceram. Empress 2 is a new lithium-silicate based glass ceramic using the hot pressing procedure. In total, 36 casts with two anterior resilient supported metal-dies for the replacement of a first upper incisor were fabricated. 18 FPDs with identical dimensions (area of connectors between pontic and abutments 16 mm<sup>2</sup>) were fabricated for each ceramic system. All FPDs were cemented with ProTec CEM (Ivoclar, FL). The FPDs were divided into 6 subgroups. The static fracture strength of 6 FPDs of each material was tested in a universal testing device. The load was applied at the center of the pontic at an angle of 30° to the long axis of the teeth. In the fatigue tests 6 bridges of the materials were treated with cyclic loading at 250 N and 600 N up to fracture events (veneer chipping or complete fracture) using a chewing simulator at 250 N with thermocycling process. Results were listed and compared using the Kruskal-Wallis test (p < 0.05). For the static fracture strength means are significantly different (Lava: veneer chipping, Empress 2: complete fracture). The numbers of load cycles for first fracture events at 600 N show no significant differences. Over 1,200,00 load cycles of 250 N FPDs of both ceramics did not fracture.

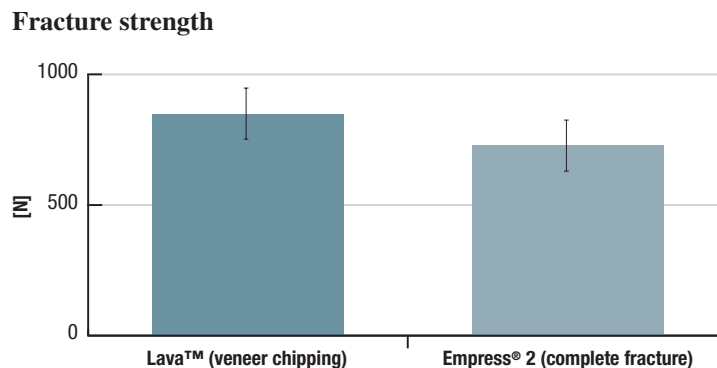
Considering the maximum chewing forces it seems possible to use the Lava as well as the Empress 2 system for anterior three-unit FPDs with high fatigue resistance.

This study was supported by Ivoclar and 3M ESPE.

Ceramics	Static Load (Mean/SD) (Lava: veneer chipping, Empress 2: complete fracture)	Amount of cycles at 600 N until fracture (Mean/SD) (veneer chipping or complete fracture)
Lava	848 ± 68 N	985 ± 379
Empress 2	729 ± 59 N	765 ± 308

**Aim of the Study:** The aim of this study was to compare the static and fatigue fracture strength of anterior 3-unit fixed partial dentures made from Empress®2 or Lava™ zirconium oxide veneered with LavaCeram.

**Result of the Study:** Considering the maximum chewing forces, Lava™ bridges out of zirconium oxide and veneered with LavaCeram are recommended for 3-unit FPDs with high fatigue resistance.



## 115

### Fracture strength of Colored Zirconia Copings with Reduced Wall Thickness

A. BEHRENS, B. BURGER, H. HAUPTMANN  
3M ESPE AG, Seefeld, Germany

**Objectives:** The objective was to show that copings out of colored Lava™ Y-TZP-ZrO<sub>2</sub> (3M ESPE) with a reduced wall thickness of 0.3 mm have sufficient fracture strength for the anterior region in order to allow the clinician a less invasive preparation. By fractographic analysis the fracture mode of the copings was ensured to be similar to clinically occurring fracture modes.

**Methods:** A total of 48 coping were produced out of colored Y-TZP-ZrO<sub>2</sub>. 24 copings were prepared from a tangential and 24 from a champher preparation and each of these were further splitted in subgroups of 12 for the fabrication of wall thicknesses of 0.3 mm and 0.5 mm. The copings were cemented with glass ionomer cement (Ketac Cem™) on brass dies and fracture strength has been subsequently determined in a universal testing machine (Zwick). The load was applied by an indented punch via a tin foil to ensure a load distribution similar to veneered copings. Fractography was done with scanning electron microscopy.

Fracture strength (N)

Wall thickness	Tangential preparation			Champher preparation		
	Mean (SD)	Min.	Max.	Mean (SD)	Min.	Max.
0.3 mm	908 (115)	714	1185	913 (106)	729	1095
0.5 mm	1476 (192)	1075	1672	1333 (107)	1180	1527

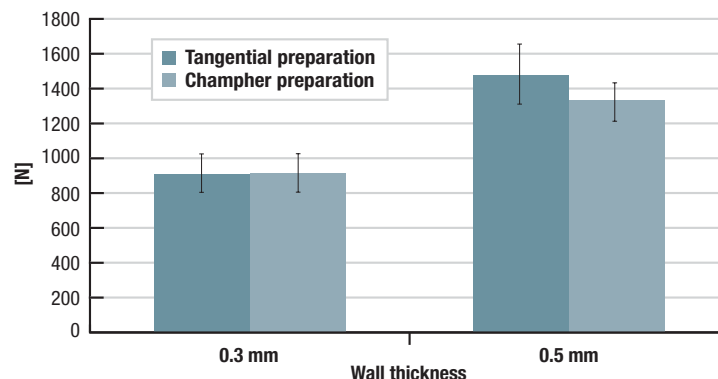
**Results:** There is no significant difference (Kruskal-Wallis test, Dunn's post test,  $p > 0.05$ ) of the fracture strength for co-pings fabricated with tangential or champher preparation but with the same wall thickness. However, there is a significant strength reduction between wall thickness of 0.5 and 0.3 mm (Kruskal-Wallis test, Dunn's post test,  $p < 0.001$ ).

**Conclusions:** The fracture strength of Y-TZP-ZrO<sub>2</sub> copings with a wall thickness of 0.3 mm is three times higher compared to the expected chewing forces in the anterior region.

**Aim of the Study:** The aim of the study was to show that a wall thickness of 0.3 mm is sufficient in the anterior region for 3M™ ESPE™ Lava™ crowns out of zirconium oxide.

**Result of the Study:** The fracture strength of the Lava™ crowns out of zirconium oxide with reduced wall thickness was about three times higher compared to the expected chewing forces in the anterior region.

Fracture strength



0578

**Bond Strength of a Self-adhesive Universal Resin Cement to Lava Zirconia after Two Surface Treatments**

D. BULOT<sup>1</sup>, A. SADAN<sup>1</sup>, J.O. BURGESS<sup>2</sup>, and M.B. BLATZ<sup>1</sup>, <sup>1</sup> Louisiana State University Health Sciences Center School of Dentistry, New Orleans, USA, <sup>2</sup> LSUHSC School of Dentistry, New Orleans, LA, USA

Surface treatment and cement selection are crucial for a strong resin bond to CAD/CAM-fabricated zirconium-oxide ceramic restorations (e.g., Lava, 3M ESPE). Current bonding systems require multiple adhesive steps and may be technique sensitive, unpredictable, and time consuming. The use of a self-adhesive resin cement might eliminate these disadvantages.

**Objectives:** This study measured shear bond strength of the self-adhesive universal resin cement RelyX Unicem (3M ESPE, group I) to Lava zirconia compared to three common cement systems (Panavia F, Kuraray (group II); RelyX ARC, 3M ESPE (III); RelyX Luting, 3M ESPE (IV)). The ceramic surface was either subject to air-particle abrasion or Rocatec Soft (3M ESPE) tribochemical surface treatment.

**Methods:** Lava zirconium-oxide ceramic samples were fabricated with the specific intaglio surface. 40 specimens were subject to air-particle abrasion (60 µm aluminum oxide) and 40 specimens were subject to Rocatec Soft tribochemical surface treatment. Composite-resin cylinders (2.9 mm dia.) were bonded to the ceramic samples with the above cements. After 72-h water storage, shear bond strengths were tested with an Instron model 4411. The data were analyzed with ANOVA and Duncan's multiple comparison ( $\alpha = 0.05$ ).

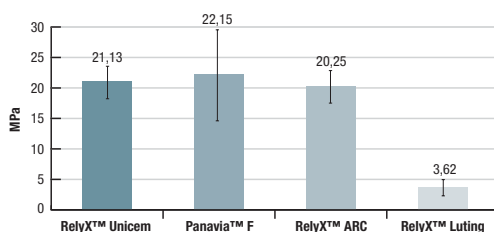
**Results:** Mean values [MPa] after sandblasting were: Group I  $21.13 \pm 2.76$  (a), Group II  $22.15 \pm 6.78$  (a), Group III  $20.25 \pm 3.08$  (a), Group IV  $3.62 \pm 0.74$  (b). Mean values after Rocatec treatment were: I  $25.01 \pm 4.49$  (c), II  $25.38 \pm 4.07$  (c), III  $23.82 \pm 3.34$  (c), IV  $5.98 \pm 1.3$  (d). Different letters in parentheses indicate statistically significant difference.

**Conclusions:** The self-adhesive resin cement RelyX™ Unicem of 3M™ ESPE™ revealed bond strengths comparable to or better than the other bonding systems under investigation. Bond strength with RelyX Luting was significantly lower than with the other cements. Surface treatment with the Rocatec system significantly improved bond strength for all bonding systems. Supported by 3M ESPE.

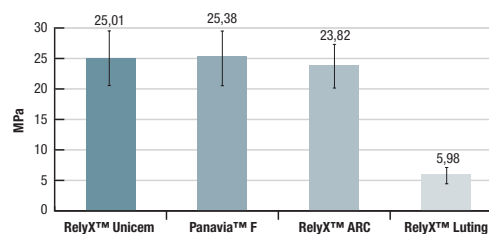
**Aim of the Study:** This study evaluated the shear-bond strength (MPa) of the self-adhesive universal resin cement RelyX Unicem to Lava zirconium oxide compared to three common cement systems after pre-treatment of air particle abrasion or tribochemical surface treatment with the Rocatec system. Shear-bond strengths were measured after 72-h water storage.

**Result of the Study:** The self-adhesive resin cement RelyX Unicem revealed bond strengths comparable to or better than the other bonding systems. Surface treatment with the Rocatec-System significantly improved bond strength for all bonding systems.

**Shear Bond Strength [MPa] –  
Pretreatment of Lava™ Zirconium  
oxide: Air Particle Abrasion**



**Shear Bond Strength [MPa] –  
Pretreatment of Lava™ Zirconium  
oxide: Tribochemical Surface  
Treatment with Rocatec System**



1650

**Resin Bond to Lava Zirconia Intaglio Surface**

K. KOEHLER<sup>1</sup>, A. SADAN<sup>1</sup>, J.O. BURGESS<sup>2</sup>, and M.B. BLATZ<sup>1</sup>, <sup>1</sup> Louisiana State University Health Sciences Center School of Dentistry, New Orleans, USA, <sup>2</sup> LSUHSC School of Dentistry, New Orleans, LA, USA Cement Expansion in Saline

Clinical recommendations for resin bonding to CAD/CAM-fabricated high-strength ceramic copings (e.g., Lava zirconia, 3M ESPE) widely depend on in-vitro studies that use ground and polished ceramic specimens. However, commercial products create a unique intaglio surface. In order to evaluate bond strength to a commercial product, one should use specimens with same intaglio surface the product has.

**Objectives:** Shear bond strengths of the bonding systems RelyX Unicem (UNI, 3M ESPE), Panavia F (PAN, Kuraray), RelyX ARC (ARC, 3M ESPE), RelyX Luting (LUT, 3M ESPE) were measured and compared to Lava zirconia intaglio surface. Bond strength to ground and polished Lava zirconia was the control.

**Methods:** 80 square samples (10x10x2 mm) were fabricated of Lava zirconia and randomly divided in two groups with different surfaces: (I) the system-specific intaglio surface and (II) a ground and polished surface. After ultrasonic cleaning, composite-resin cylinders were bonded to the zirconia specimens with the above cements. Shear bond strengths were tested with an Instron after 72 h storage in distilled water. The data were analyzed using ANOVA and Duncan's multiple comparison ( $\alpha = 0.05$ ).

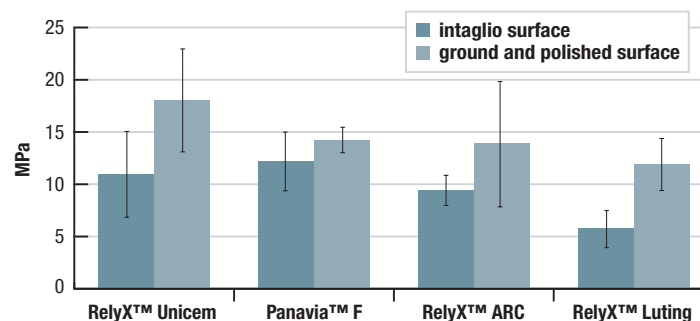
**Results:** For group I, mean bond strength values were: UNI  $10.95 \pm 4.28$  MPa (a), PAN  $12.20 \pm 2.62$  MPa (a), ARC  $9.45 \pm 1.89$  MPa (a), LUT  $5.75 \pm 1.53$  MPa (b). Mean values for group II: UNI  $18.03 \pm 5.05$  MPa (c), PAN  $14.18 \pm 1.24$  MPa (c), ARC  $13.95 \pm 5.81$  MPa (c), LUT  $11.88 \pm 2.57$  (d). Same letters in parentheses indicate no statistically significant difference.

**Conclusions:** Surface configuration had a significant influence on the bond strength to Lava zirconia: bond strength to the Lava intaglio surface was significantly lower than to the polished surface. UNI, PAN, and ARC were not different from each other but significantly higher than LUT, regardless of surface configuration. Supported by 3M™ ESPE™

**Aim of the Study:** The bond strength of different cements to Lava zirconium oxide was the subject of this study.

**Result of the Study:** The adhesive composite cements and RelyX™ Unicem of 3M™ ESPE™ showed significantly better adhesion than the resin-modified glass ionomer cement. By a process of grinding, the adhesion of all groups could be further increased.

**Shear Bond Strength to Lava zirconium oxide**



0060

## Long-term Shear-bond Strength of Luting Cements to Zirconia Ceramic

A. PIWOWARCZYK, K. LINDEMANN, P. OTTL, and H.-C. LAUER, University of Frankfurt, Germany

**Objectives:** This study evaluated the long-term shear-bond strength of cements to zirconia ceramic (Lava, 3M ESPE) after two pre-treatment procedures.

**Methods:** One half of the zirconia samples were air-abraded with 100-micrometer alumina at 2.8 bar, 10 s at 10 mm distance (pre-treatment I); the other half was tribochemically silica-coated with the Rocatec-System (3M ESPE) (pre-treatment II). Materials tested: 1a) PermaCem self-cured (SC) (DMG), 1b) PermaCem light-cured (LC), 2a) RelyX ARC SC (3M ESPE), 2b) RelyX ARC LC, 3a) Panavia F SC (Kuraray), 3b) Panavia F LC, 4a) Variolink II SC (IvoclarVivadent), 4b) Variolink II LC, 5a) Nexus2 SC (Kerr), 5b) Nexus2 LC, 6a) Calibra SC (DentsplyDeTrey), 6b) Calibra LC, 7a) RelyX Unicem SC (3M ESPE), and 7b) RelyX Unicem LC. Eight specimens per group were fabricated: Group (A) was aged and tested after 150d 37°C water storage; Group (B) 150d at 37°C water storage, then thermocycled (37.500X, 5-55°C). One-way ANOVA of variance was used to analyze the data ( $p < 0.05$ ).

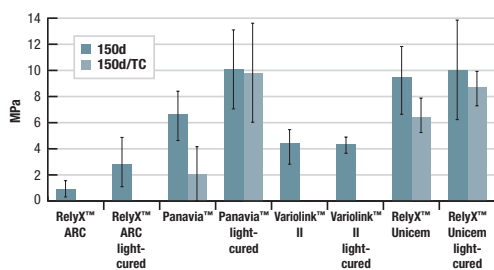
**Results:** Using pre-treatment I cements 3b, 7a and 7b showed highest shear-bond strengths independent of ageing procedure. Using pre-treatment II the highest values were achieved by cements 7b and 1b with  $13.4 \pm 1.1$  MPa and  $12.1 \pm 3.8$  MPa in ageing group (A). The highest results in ageing group (B) were achieved for 4b with value of  $11.2 \pm 4.5$  MPa. 3b, 7b and 1b followed with results of  $9.9 \pm 2.5$  MPa,  $8.9 \pm 2.1$  MPa and  $8.2 \pm 2.9$  MPa respectively.

**Conclusions:** Bonding to air-abraded zirconia of cements 3b, 7a, and 7b was superior to all other materials independent of ageing procedure. Most stable bonding to tribochemically silica-coated zirconia was found with cements 1a, 1b, 3b, 4b, 7a and 7b.

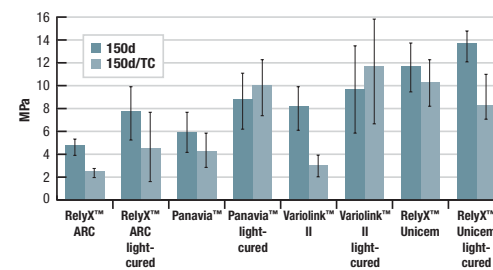
**Aim of the Study:** This study evaluated the shear-bond strength of different cements to 3M™ ESPE™ Lava™ zirconium oxide after different pretreatments of the zirconium oxide surface and artificial ageing after water storage and water storage in combination with thermocycling.

**Result of the Study:** Air-abraded Lava zirconium oxide showed one of the best bondings to RelyX™ Unicem LC and RelyX™ Unicem SC of 3M™ ESPE™ independent of the artificial ageing. This was also confirmed by means of a pretreatment with the Rocatec System. Whereas in the case of a pretreatment with the 3M™ ESPE™ Rocatec System the absolute values are higher in comparison to the sandblasted samples.

Lava™ / Al<sub>2</sub>O<sub>3</sub> Shear Bond Strength



Lava™ / Rocatec™ Shear Bond Strength



3178

Adhesion of Glass Ionomer Cements to Crowns and Hard Tissues

A. FALSAFI, T.T. TON, B.R. BROYLES, and D.D. KRUEGER, 3M ESPE Dental Products, St. Paul, MN, USA

**Objectives:** The goal of this study was to compare the adhesion of different self-cure conventional and resin-modified glass ionomer luting cements to different crown materials. The cements used were three commercial RMGI materials: RelyX Luting or Vitremer Luting (RLC, 3M ESPE), FujiCEM (FC, GC), Fuji Plus (FP, GC); one commercial conventional GI: Fuji I (F1, GC); and one experimental RMGI cement (ExpC, 3M ESPE). RLC, FP and F1 are powder/liquid systems while FC and ExpC are paste/paste.

**Methods:** For adhesion to Lava, Procera and Rexillum surfaces were sand-blasted. Five specimens of each category were cemented and allowed to cure at 37 C°/95% RH for 20 min and immersed in 37° C deionized water for 24 h. The bond strengths were measured in shear mode using Instron.

**Results:** The mean values including their standard deviations in the parentheses are summarized in the following table:

Luting Cement	Shear Bond Strength to Lava (Ad-L), MPa	Shear Bond Strength to Procera (Ad-P), MPa	Shear Bond Strength to Metal (Ad-M), MPa
ExpC	27(3)	14(2)	11(3)
RLC	14(2)	11(3)	7(1)
FC	11(3)	9(1)	10(3)
FP	14(2)	10(3)	12(2)
F1	2.8(0.5)	2.8(1.6)	6.7(1.6)

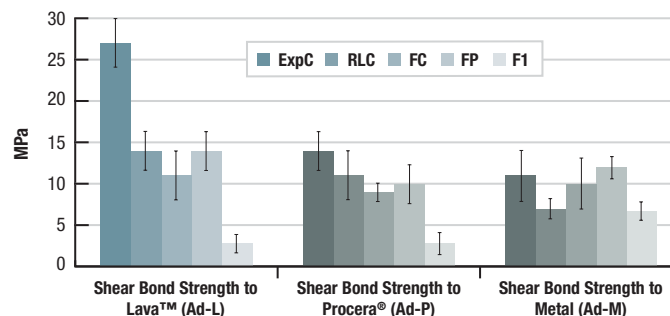
Comparison of different dispensing systems as well as adhesion to bovine enamel and dentin will be presented.

**Conclusions:** ANOVA analysis was performed at  $p < 0.05$ . ExpC had significantly higher adhesion to Lava and Procera substrates than FC, FP, and F1. In general, resin-modified cements had significantly higher bond strengths to ceramics than F1 conventional cement.

**Aim of the Study:** The aim of the study was to measure shear bond strength of different selfcure conventional and resin-modified glass ionomer luting cements to 3M™ ESPE™ Lava™ zirconium oxide in comparison to other crown materials.

**Result of the Study:** 3M™ ESPE™ RelyX™ Luting Plus (= ExpC) had significantly higher adhesion to Lava™ zirconium oxide compared to the other crown and luting materials.

Adhesion of Glass Ionomer Cements to Crowns and Hard Tissues



# 1779

**Light Transmission Through All-Ceramic Framework and Cement Combinations**  
 D. EDELHOFF, University of Aachen, Germany, and J. SORENSEN, Oregon Health & Science University, USA

**Objectives:** This study quantified the light transmission through all-ceramic frameworks dependent on two luting materials (LM).

**Methods:** Disk shaped specimens (16x0.9 mm) were made of various ceramics of shade A3 (Vident): **A**) Densely sintered Al<sub>2</sub>O<sub>3</sub>, **EX**) Experimental (OHSU-RWTH, Ivoclar Vivadent (IV)), **IA**) Infiltrated Al<sub>2</sub>O<sub>3</sub> (In-Ceram(IC) Alumina, Vident), **IS**) Infiltrated MgAl<sub>2</sub>O<sub>4</sub> (IC Spinell), **IAZ**) Infiltrated Al<sub>2</sub>O<sub>3</sub>/ZrO<sub>2</sub> (IC Zirconia), **L**) Lithium disilicate (Empress2, IV), **Z**) ZrO<sub>2</sub>-Y<sub>2</sub>O<sub>3</sub> (Lava, 3M ESPE). Ceramic disks were covered with a 0.1 mm layer of **1**) zinc phosphate (Harvard Dental) or **2**) dual cured resin cement (Variolink transparent, IV). As reference (**3**)), uncovered 1 mm ceramic disks were employed. Samples (3/group) were tested after 30 days storage in artificial saliva. Light transmitted through the specimen was determined in a spectrophotometer (DU-7, Beckman) by direct transmission coefficient (t<sub>c</sub>) [%] for wavelengths (λ) from 400 to 700 nm.

**Results:** Values are given as overall t<sub>c</sub>, calculated as integral 400-700 t<sub>c</sub>(λ)dλ, means (SD):

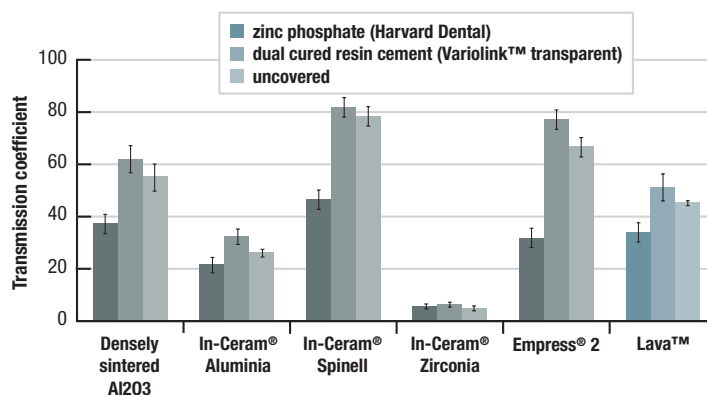
	Al <sub>2</sub> O <sub>3</sub>	EX	Inceram	Spinell	Inceram Zirconia	Empress	Lava
1)	37.2 (3.0)ab	42.9 (3.8)b	21.6 (1.6)	46.6 (3.2)b	5.6 (0.7)I	31.8 (2.8)a	34.1 (2.3)a
2)	61.8 (5.0)c	400.6 (34.6)	32.4 (1.5)	81.8 (4.0)d	6.3 (0.9)I	77.3 (4.9)d	51.2 (5.8)Zc
3)	55.2 (4.4)	301.7 (47.8)	26.1 (0.3)	78.5 (3.6)	4.9 (0.6)I	66.7 (3.0)	45.3 (1.1)Z

**Conclusions:** ANOVA showed significant (p < 0.05) differences among the overall t<sub>c</sub> values dependent on type of ceramic and LM (n.s. = same superscript). Overall t<sub>c</sub> increased significantly when LM-2 was used. Higher translucency ceramics showed greater sensitivity to luting material type than the more opaque ceramics.

**Aim of the Study:** The aim of the study was to show the dependence of light transmission on different luting cements.

**Result of the Study:** The more transparent materials showed a higher dependence on the luting material. Moreover, 3M™ ESPE™ Lava™ zirconium oxide shows a high translucency compared to other materials like In-Ceram, even though the lower wall thickness which is necessary for Lava™ restorations was not considered in this experiment and would further improve the translucency.

**Light transmission depending on luting material**



1455

**Milling Time vs. Marginal Fit of CAD/CAM-manufactured Zirconia Restorations**

G. HERTLEIN, M. KRAEMER, T. SPRENGART, and K. WATZEK, 3M ESPE AG, Seefeld, Germany

**Objectives:** Faster manufacturing of all-ceramic restorations is the key factor for the economic performance of a CAD/CAM system. On the other hand clinical relevant parameters which are determining the quality of the final restoration should not be influenced by the milling time. The aim of this study was to determine whether the marginal fit of CAD/CAM manufactured zirconia bridges is deteriorating if the milling time is decreased. This reduction was achieved by optimizing the milling strategies and the processing parameters.

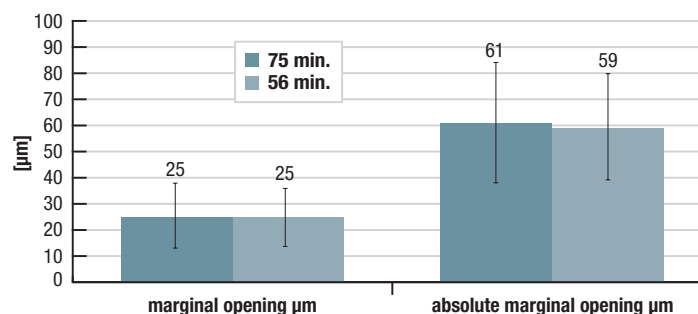
**Methods:** The Lava™ (3M ESPE AG) Zirconia bridge frameworks were processed with the Lava System. After manufacturing each framework coping was cemented on the scanned dies and subsequently embedded into acrylic. Specimens were sectioned faciolingually and mesiodistally. A stereomicroscope and a special analyzing-software (analysis, Soft Imaging System GmbH) were used for the determination of the marginal opening (MO) and the absolute marginal opening (AMO) of the cross-sections (acc. to Homes et al., J. Prosth. Dent. 1989;62:405-408). Five samples (two anterior and three posterior 3 unit-frameworks) were milled in the standard process (75 min) and the optimized process (56 min). Six data points per sample were equally spaced around the margins (n = 30).

**Results:** For the two milling times (75 and 56 min respectively) we found the following means for the MO- and AMO-values in  $\mu\text{m}$ : MO:  $25 \pm 12$ ;  $25 \pm 10$ ; AMO:  $61 \pm 25$ ;  $59 \pm 21$ . These values are comparable to the data of CAD/CAM manufactured In-Ceram zirconia bridges from Vita (Tinschert et al., Oper Dent 2001;26(4):367-374). No difference between the standard and the faster milling process was observed within the MO and AMO-groups by using additional statistical analysis (One-way ANOVA;  $p \geq 0.05$ ).

**Conclusions:** A reduction of the milling time for 3-unit zirconia bridge frameworks by 25% results in the same precision of fit (AMO:  $59 \pm 21 \mu\text{m}$ ) like the standard milling process.

**Aim of the Study:** This study evaluated the influence of the milling time and the corresponding milling process optimization steps respectively on the marginal fit of 3M™ ESPE™ Lava™ zirconium oxide bridges. The bridges were produced with the Lava CAD/CAM System. The time could be reduced by optimizing the milling strategies and the processing parameters.

**Result of the Study:** No difference between the standard and the faster milling process was observed concerning the marginal fit within the MO and AMO-groups. The Lava™ system makes it possible to reduce the milling times for 3-unit bridges by 25% while ensuring the same quality.

**Marginal Fit depending on Milling Time**

## 0122

### Marginal Adaptation of CAD-CAM ZrO<sub>2</sub> Ceramic with Different Cements

M. ROSENTRITT\*, M. BEHR, R. LANG, G.GRÖGER, G. HANDEL, Department of Prosthetic Dentistry, University of Regensburg, Germany

The aim of this study was to investigate the marginal adaptation between CAD-CAM ZrO<sub>2</sub> all-ceramic fixed partial dentures (FPDs) and human teeth using different cements. 32 three-unit FPDs were fabricated of the CAD-CAM ZrO<sub>2</sub> all-ceramic Lava/Lava Ceram (3M ESPE, G) and fixed on human molars using the resin composites Variolink II/Syntac Classic (Ivoclar-Vivadent, FL), Panavia F/ED (Kuraray, J), Compolute/EBS Multi and a novel self-adhesive universal resin cement RelyX Unicem (both 3M ESPE). Before and after thermal cycling and mechanical loading (TCML: 6000x5° /55°C, H2O, 2 min. each cycle, 1.2\*106x50 N) the marginal adaptation was determined using scanning electron microscopy on resin replica. Microleakage was assessed at the cervical margins by a dye penetration test after TCML (0.5% fuchsine sol., 16 hrs).

**Statistics:** Mann-Whitney-U-test (p ≤ 0.05).

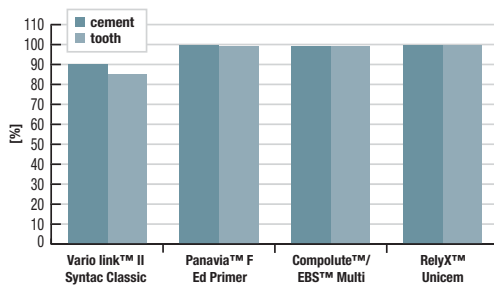
Before/after TCML	Margin:	Variolink 2	Panavia F	Compolute	RelyX Unicem
Perfect margin [%]	cement/tooth	90.0/85.0	99.5/99.0	99.0/99.0	99.5/99.5
	cement/crown	92.0/85.5	99.0/99.0	100.0/98.5	98.5/98.0
Microleakage [%]	cement/tooth	76.5	0.0	3.0	0.0
	cement/crown	100.0	3.5	2.5	0.0

After stress simulation, all cements showed comparable good marginal adaptation to the CAD CAM ceramic Lava, only for Variolink II significantly lower parts of perfect margin and higher micro-leakage were found. For RelyX Unicem without bonding no differences were found in comparison to Compolute or Panavia F. Panavia F, Compolute and RelyX Unicem showed no limitation for the cementation of CAD-CAM ZrO<sub>2</sub> FPDs.

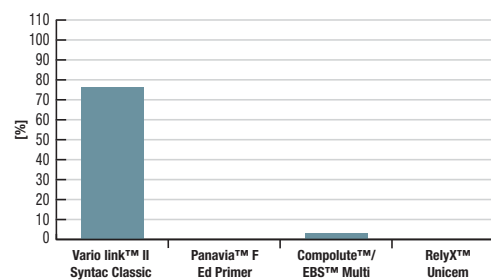
**Aim of the Study:** This study examined the marginal adaptation and marginal seal of fixed Lava bridges out of zirconium oxide and veneered with 3M™ ESPE™ Lava™ Ceram that were cemented using different cements and subsequently were exposed to mechanical as well as thermal load in the mastication simulator.

**Result of the Study:** RelyX™ Unicem of 3M™ ESPE™ showed the same excellent results after the stress test as did Panavia™ F / Ed Primer and Compolute™ / EBS Multi.

**Perfect Margin**



**Microleakage (cement/tooth)**



# 1092

### Marginal Fit of CAD/CAM Manufactured All Ceramic Zirconia Prostheses

G. HERTLEIN\*, S. HOESCHELER, S. FRANK, D. SUTTOR, 3M ESPE AG, 82229 Seefeld, Germany

The use of presintered zirconia blanks for CAD/CAM manufactured prostheses has the advantage of reduced production time and less tool wear. However, in contrast to metals, the sintering shrinkage has to be controlled to a high accuracy. The aim of this work was to verify whether the same precision of fit can be achieved by using either presintered zirconia or metal (brass, titanium). The hereby used CAD/CAM system which 3M ESPE is currently developing consists of an optical scanner device, a software module and a three axis milling machine. Conventional cutting tools were used for shaping the coping. After manufacturing each coping was cemented on the scanned dies using a bonding (Nimetic-Bond®, 3M ESPE) and subsequently embedded in epoxy. Specimens were sectioned faciolingually and mesiodistally. A stereomicroscope and a special analyzing-software (analySIS, Soft Imaging System GmbH) was used for the determination of the marginal opening (MO) and the absolute marginal opening (AMO) of the cross-sections (acc. to Holmes et al., J. Prosth. Dent. 1989;62:405-408). Anterior teeth, molar and premolar copings were used for these investigations. For each material five crowns with three points of measurements each were taken for statistic evaluation (see table below). All data points were equally spaced along the crown margins.

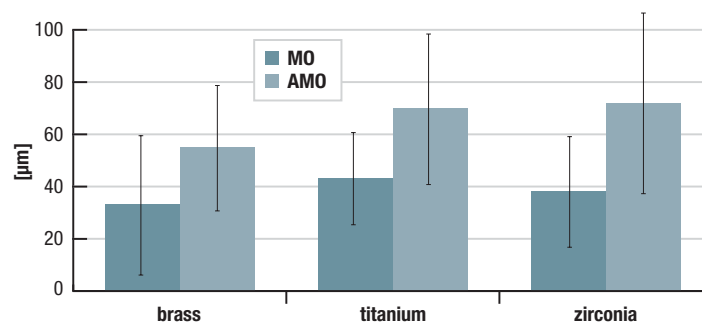
	Brass	Titanium	Zirconia	
MO:	33 ± 25 µm	43 ± 19 µm	38 ± 20 µm	(means ± standard deviations; n = 15)
AMO:	55 ± 24 µm	70 ± 22 µm	72 ± 36 µm	(means ± standard deviations; n = 15)

These values are comparable to the data of Procera crowns (May et al., J. Prosth. Dent. 1998;80:394-404). No difference between the considered materials was observed within the MO and AMO groups by using additional statistical analysis (pairwise t-test,  $p \leq 0.05$ ). This investigation showed that the used presintered zirconia blanks can be machined and sintered to the same high precision (AMO: 72 ± 36 µm) as achieved with metals, e.g. titanium (AMO: 70 µm ± 22 µm).

**Aim of the Study:** The aim of this work was to verify whether the same precision of fit can be achieved by using either presintered zirconium oxide or metal (brass, titanium) within the CAD/CAM process of the Lava system.

**Result of the Study:** No statistical significant differences between the investigated materials were observed. By using the 3M™ ESPE™ Lava™ system presintered zirconium oxide blanks can be machined and sintered to the same high precision as achieved with metals, e.g. titanium. Milled Lava™ zirconium oxide restorations show an excellent marginal fit.

**Marginal fit of crowns**



1355

**Clinical Connector Dimensions of CAD/CAM-produced All-ceramic FPDs**  
S. REICH, University of Erlangen-Nuremberg, Germany

**Objectives:** The aim of this investigation was to evaluate the clinical practicability of the connector dimensions of two machinable ceramic framework materials for three unit FPDs up to a maximum total length of 30 mm.

**Methods:** 20 patients, who showed the indications of a three unit FPD were divided into two groups by chance. For group [A] InCeram Zirconia frameworks [ZIR] were milled with the Cerec Inlab™ system and for group [B] Y-ZrO<sub>2</sub> [ZRO] frameworks were manufactured with the Lava™ system. Before laminating, the mesial and distal connector dimensions, the mesial and distal maximum vertical dimension of the connectors and the distance between mesial and distal abutment were measured and compared with the respective manufacturers recommendations. The data of [ZIR] and [ZRO] were statistically compared with the CHI square test whether the recommended connector dimensions could be kept or not.

**Results:** In the [ZRO] group the dimensions of 19 out of 20 connectors (10 frameworks, 2 connectors each) were within the recommended dimensions. One connector (8.8 mm<sup>2</sup>) was below its recommendation of 9 mm<sup>2</sup>. In the [ZIR] group it was not possible to keep the recommended connector dimensions due to limited intraoral dimensions in 16 cases.

Group	N	recommended dimension kept	recommended dimension not kept
[A]	20	4	16
[B]	20	19	1

According to the CHI square test the data between [A] and [B] differ significantly at  $p \leq .05$ .

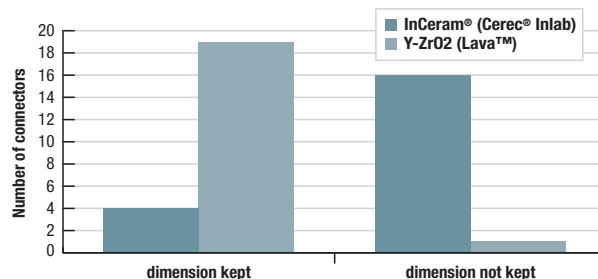
**Conclusions:** The recommended connector dimensions for [ZIR] are still based on the Zirconia slip cast technology and might not consider the improved material properties of standardized manufactured machinable [ZIR] material. According to the results of this investigation [ZRO] promises a wider range of indications. With respect to these facts pure ZrO<sub>2</sub> machinables have been developed for the Cerec InLab™ meanwhile.

Granted by 3M ESPE AG, Vita Zahnfabrik, Sirona Dental Systems

**Aim of the Study:** This study evaluated the clinical practicability of the connector dimensions of InCeram® Zirconia frameworks (Cerec Inlab™) and Lava™ zirconium oxide frameworks (3M ESPE) for 3 unit bridges up to 30 mm length.

**Result of the Study:** In the Lava zirconium oxide (3M ESPE) group 19 out of 20 connectors kept the recommended connector dimensions whereas only 4 kept it in the InCeram Zirconia (Cerec Inlab™) group. Therefore Lava™ zirconium oxide (3M ESPE) promises a wider range of indications from a functional as well as an aesthetical view.

**Clinical Connector Dimensions**



# 0817

### Clinical Evaluation of Zirconia-based All-ceramic Posterior Bridges: Two-year Results

P.R. POSPIECH<sup>1</sup>, P.R. ROUNTREE<sup>2</sup>, and F.P. NOTHDURFT<sup>1</sup>, <sup>1</sup> Saarland University/Homburg, Homburg/Saar, Germany, <sup>2</sup> Ludwig-Maximilians-University, Munich, Germany

With modern CAD/CAM-Systems high-strength Zirconia ceramics can be used for the fabrication of all-ceramic crowns and bridges. Conventionally fixed bridges including the replacement of molars are now recommended by the manufacturer. Previous own in-vitro experiments on three and four-unit posterior bridges revealed high enough strength results that a clinical study could be ventured.

**Objectives:** The purpose of this prospective study was to observe the clinical performance of posterior bridges for the replacement of molars.

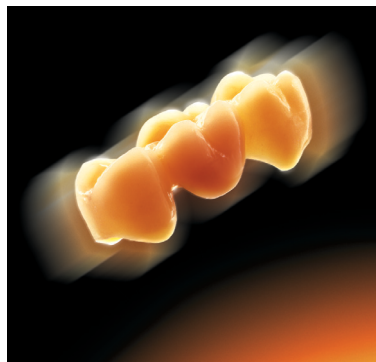
**Material and Methods:** Since October 2000 a total of 38 bridges were placed in 36 patients: All abutments were prepared for full crowns. A chamfer of 1.2 mm depth was prepared in all cases. Impressions were made with the polyether materials Impregum Penta/Permadyne. The wall-thicknesses of the zirconia-core were constant 0.6 mm, the connector area was designed with a cross-sectional plane of 9 mm<sup>2</sup>. The bridges were cemented conventionally with the glass-ionomer cement Ketac Cem. Recalls were made after 2 weeks, 6, 12 and 24 months. Judgments were made on the fit of the bridges on the abutments, discoloration of the marginal gingiva, the quality of the surface, failures and allergenic reactions.

**Results:** All bridges were only inserted with a perfect marginal fit. In three cases the Zirconia frames had to be milled two times. The mean observation-period was 16.8 months (in October 2002). No total failures were observed, in one case a small chipping of the veneering material happened. No allergenic reactions and negative influences on the marginal gingiva could be observed.

**Conclusions:** After two years of clinical service one can conclude a good performance of Zirconia based posterior bridges although the time of clinical service is not long enough for general recommendations. This study was supported by 3M ESPE, Seefeld, Germany.

**Aim of the Study:** This study evaluated the clinical performance of posterior 3M™ ESPE™ Lava™ bridges out of zirconium oxide and veneered with LavaCeram. The mean observation time was 16.8 months.

**Result of the Study:** No total failures, no allergenic reactions nor negative influences on the marginal gingiva could be observed. A very good performance of Lava™ posterior bridges can be concluded after two years.



# 230

### **A prospective study on the long-term behavior of Zirconia-based bridges (Lava): results after three years in service**

P. POSPIECH, F. NOTHDURFT Dept. of Prosthetic Dentistry and Dental Materials Science, Saarland University, Homburg, Germany

Using CAD/CAM-processing high-strength Zirconia ceramics can be used even for the fabrication of all-ceramic bridges. The strength of the materials allows the conventional cementation which simplifies the daily clinical life. Some in-vitro studies on three- and four-unit posterior bridges revealed that the strength is high enough to run controlled clinical studies.

**Objectives:** The purpose of this prospective study was to observe the clinical performance of posterior bridges for the replacement of molars.

**Material and Methods:** Since October 2000 a total of 35 bridges were placed. All abutment teeth were prepared for full crowns. A chamfer with a depth of maximum 1.2 mm was prepared in all cases. Impressions were made with the polyether materials Impregum Penta/Permadyne. The axial wall-thicknesses of the zirconia-cores were constant 0.6 mm, the connector area was designed with a cross-sectional plane of minimum 9 mm<sup>2</sup>. The bridge frameworks were veneered with the newly developed overlay porcelain LavaCeram. All restorations were cemented conventionally with the glass-ionomer cement Ketac Cem. Recalls took place in December 2003 after an observation time of three years. 30 bridges could be evaluated at that time. Judgements were made on the fit of the bridges on the abutments, discoloration of the marginal gingiva, the quality of the surface, failures and allergenic reactions.

**Results:** All bridges were only inserted with a perfect marginal fit. No changes in fit or secondary caries were observed. No total failures happened, in one case a small chipping of the veneering material took place. No allergenic reactions and negative influences on the marginal gingiva could be observed.

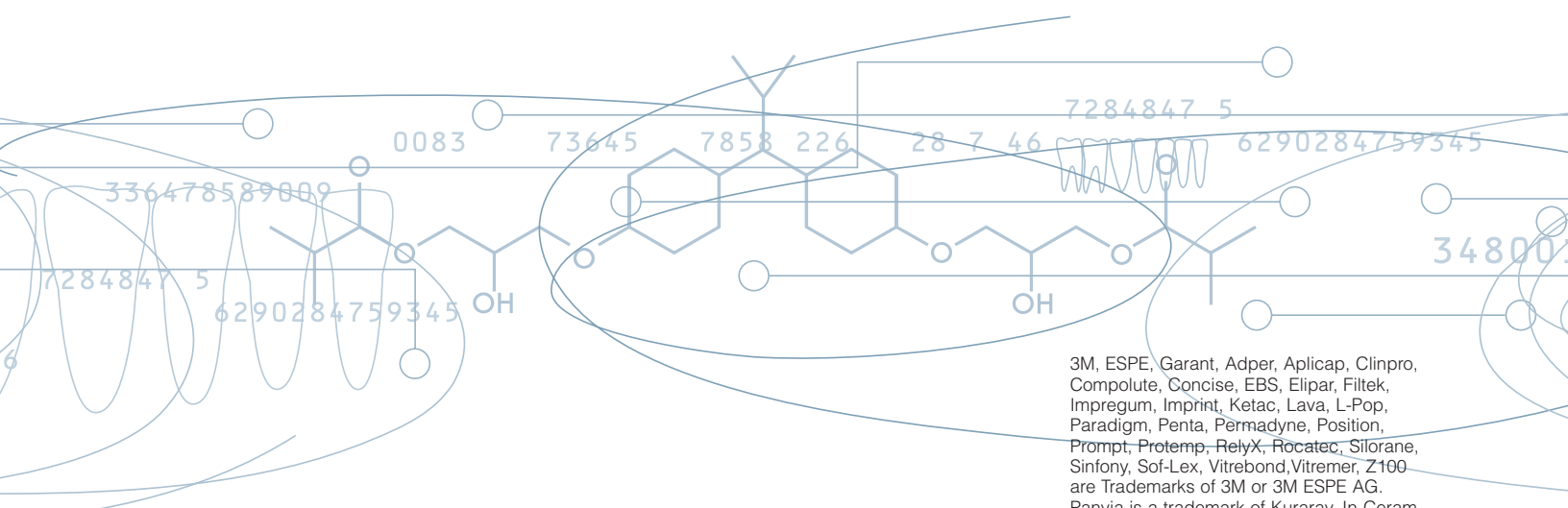
**Conclusions:** After three years of clinical service one can conclude a high performance of Zirconia based posterior bridges.

This study was supported by 3M ESPE, Seefeld, Germany.

**Aim of the Study:** This study evaluated the clinical performance of posterior 3M™ ESPE™ Lava™ bridges out of zirconium oxide and veneered with LavaCeram.

**Result of the Study:** No total failures, no allergenic reactions nor negative influences on the marginal gingiva could be observed. A very good clinical performance of Lava™ posterior bridges can be concluded after up to three years.





## 3M ESPE

### Dental Products

3M Center  
Building 275-2SE-03  
St. Paul, MN 55144-1000  
USA

### 3M Canada

Post Office Box 5757  
London, Ontario N6A 4T1  
Canada  
1-800-265-1840 ext. 6229



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