Clinical outcomes of zirconia-reinforced lithium silicate partial coverage crowns compared to lithium disilicate partial coverage crowns. A randomized controlled split-mouth clinical study [version 1; peer review: 1 approved, 1 not approved]

Hanaa Nassar, Carl H Halim, Hesham A Katamish

Department of Fixed Prosthodontics, Faculty of Oral and Dental Medicine, Cairo University, Cairo, Egypt

Abstract

Background: Despite the fact that preliminary clinical results of conservative partial coverage restorations (PCRs) are promising, the clinical behavior of different PCR ceramic materials is rarely investigated in clinical trials. This study aimed to evaluate the clinical outcomes of partial coverage restorations (PCR) fabricated with zirconia-reinforced lithium silicate ceramic system compared to partial coverage restorations fabricated with lithium disilicate ceramic system.

Methods: 46 vital premolars and molars of 14 patients were restored with PCRs (23 Vita Suprinity and 23 IPS e.max CAD). PCRs were CAD/CAM fabricated in the lab and adhesively luted with dual-polymerizing resin cement (Duolink. BISCO, USA). Clinical evaluation of PCRs was performed according to the Modified United States Public Health Service (USPHS) at baseline, 6 and 12 months post-insertion. Absolute failure was demonstrated by Kaplan-Meier survival rate analysis.

Results: After 12 months observation, all PCRs of both ceramic groups demonstrated 100% survival rate. Non-significant decrease in Alpha ratings for marginal adaptation (p = 0.1560) and marginal discoloration (p = 0.6078) in e-max group. While in the Suprinity group, PCRs demonstrated 100% Alpha ratings for marginal adaptation and only one Bravo rating (p= 0.3625) for marginal discoloration after 12 month observation.

Conclusions: Both Vita-Suprinity and e.max CAD partial coverage restorations are considered reliable treatment options for restoring larger defects in posterior dentition.

Trial registration: ClinicalTrials.gov NCT02861729 04/08/2016
Keywords
Partial coverage restorations, posterior teeth, ceramic, Zirconia reinforced lithium silicate, lithium disilicate, CAD/CAM

This article is included in the All trials matter collection.
**Introduction**

High survival rates, fracture resistance and proper marginal integrity of CAD/CAM partial coverage restorations (PCRs) were reported in studies simulating 5-year clinical service[^1^-^4]. However, clinical behavior of PCRs utilizing morphology driven preparation design was never assessed in randomized clinical trials[^5^-^11].

Furthermore, long-term clinical studies have shown that bulk fracture and marginal deterioration of PCRs has a direct correlation to the use of brittle ceramic materials, such as feldspathic and leucite-based ceramics[^12^-^15], which encouraged researchers to use higher strength lithium disilicate glass ceramic in such restorations[^16^-^21]. Although some clinical studies tested the performance of lithium disilicate PCRs, no randomized clinical trial tried to compare between lithium disilicate ceramic material and the newly introduced zirconia-reinforced lithium silicate ceramic material in posterior partial coverage[^22^-^24].

The aim of this randomized controlled split-mouth clinical study was to evaluate the clinical outcomes of zirconia-reinforced lithium silicate (Vita Suprinity) and lithium disilicate (IPS e.max CAD) partial coverage restorations. The null hypothesis was that there would be no difference between the two ceramic materials over 12 months.

**Methods**

**Ethical considerations and consent**

This study was approved by Ethics Committee of Faculty of Oral and Dental Medicine in October 2016 (Approval number: 03102016).

Written informed consent for all the study procedural steps and publication of their clinical results and images were obtained from the patients.

This trial was registered with ClinicalTrials.gov under trial number NCT02861729 on the 04/08/2016.

**Study design**

This study was a double blinded, split-mouth randomized controlled clinical trial, with an allocation ratio of 1:1.

This article was written in concordance with the CONSORT checklist 2010 (see Reporting guidelines).

**Participants**

All patients were recruited from the outpatient clinic of the Department of Fixed Prosthodontics, Faculty of Oral and Dental Medicine, Cairo University, Cairo, Egypt. Between May 2017 and June 2017, a total of 14 adult patients (8 females and 6 males) were included in this study after fulfilling all inclusion criteria. A total of 46 premolars and molars (20 maxillary and 26 mandibular) were restored in this study, according to split-mouth design; at least two restorations (one of each ceramic material) were placed in each patient.

**Inclusion criteria:**

- Adult patient aged 18–50 years old. Patient with good oral hygiene (papillary bleeding index (PBI < 35%).
- Teeth: vital, with large carious lesions/defective restorations and teeth in occlusion.

**Exclusion criteria:**

- Patient with severe systemic disorder, smokers, xerostomia or buxism
- Teeth: non-vital, endodontically treated, mobile or periodontally affected teeth.

**Sample size**

Based on the previous paper by Guess et al. 2009[^15], the probability of surface roughness among interventions is 0.48. If the true probability among controls is 0.11, it was estimated that a total of 46 samples (n= 23 of each ceramic material group) would be required to reject the null hypothesis that the exposure rates for case and controls are equal with probability (power) 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05. Sample size was calculated using G* Power program, version 3.0.10.

**Randomization**

A random sequence was generated by computer software (http://www.randomizer.org/) in the Center of Evidence Based Dentistry, Cairo University. The table was kept with the assistant supervisor (CHH). Participants received numbered papers each contains a number from 1 to 2 representing ceramic material and a letter R or L representing the side where PCR will be placed on folded paper placed in sealed opaque envelopes. The patient selected the ceramic material for the first tooth randomly, and then the following tooth received the alternate ceramic material according to the split-mouth design.

**Interventions**

All clinical steps were performed by one operator (HN) and laboratory steps by one technician.

**First visit (teeth preparation)**

A new cavity preparation design; morphology driven preparation (MDP) design was selected for this study. In this design, preparations were guided by the anatomical and structural morphology of the teeth[^25^-^27].

Interior walls were prepared with 6–10° divergence, well-defined margins and rounded inside angles. Inter-proximal box was prepared with 1–1.2mm butt-joint, all obtained with medium-grit 80μm diamond truncated conical bur (4137-856-025, Microdont, USA). (Figure 1)

Occlusal reduction of 1.5–2mm was performed with egg-shaped football bur (3118-368-023, Microdont, USA), and verified with silicon index. The outer axial walls with inclined planes were prepared with hollow chamfer margin obtained with round bur (1014-801-014, Microdont, USA). (Figure 2)
Final PCRs were designed using CAD/CAM software (Exocad-DentalCAD, Exocad GmbH-Slovenia) and milled with 5-axis machine (CAM5-S1 impression.Vhf, Ammerbuch-Germany) of Suprinity (VITA-Zahnfabrik H. Rauter-GmbH-Germany, Catalogue no.: 2002E – 0114 (X.) S Version (02)) and e.maxCAD (Ivoclar-Vivadent, Schaan-Liechtenstein, Catalogue no.: 721198/e/2018-11) blocks. After staining, PCRs crystallization was done in ceramic furnace (Programat-P310) according to manufacturer instructions.

**Second visit (PCRs try-in and bonding)**

Definitive PCR try-in was performed to confirm the restoration proper seating, marginal integrity, shade matching and proper occlusal and proximal contacts.

All PCRs bonding steps were performed under rubber-dam isolation.

The internal surfaces of PCRs were etched for 20 second with 9.5% hydrofluoric acid (BISCO-USA, Catalogue no.: E-5702EP), rinsed, air dried, then Bis-silane (BISCO-USA, Catalogue no.: B-2221P) was applied, left for 60 seconds and air dried. Enamel margins of the preparations were etched with 37% phosphoric acid (BISCO-USA) for 30 seconds, rinsed and air dried. All-bond universal adhesive was applied, air thinned, and cured for 20 seconds (Elipar™, 3MESPE, USA, Catalogue no.: 70-2013-0430-3-B). Duolink adhesive resin cement (BISCO-USA, Catalogue no: A-19010P), was applied to fitting surface; restoration was seated with gentle pressure, glycerin barrier was applied to margins (Deox.Ultradent-USA, Catalogue no: 238), then light curing was performed for 40 seconds (Elipar™, 3MESPE, USA, Catalogue no.: 70-2013-0430-3-B).

Residual cement was removed and occlusion was carefully checked.

**Clinical evaluation**

The PCRs were assessed for clinical outcomes by an independent outcome assessors according to the modified United States Public Health Service (USPHS) criteria at baseline, 6 and 12 months post-treatment. PCRs were visually inspected with mirror, probe and dental floss; all changes were recorded and photographed.

**Primary outcome: survival rate**

For survival rate, only Alpha ratings were considered success. Absolute failure was defined by loss of retention, fracture, crack development which required a replacement of the entire restoration, secondary caries or endodontic complications (Table 1).

**Secondary outcomes: marginal adaptation and marginal discoloration**

Alpha and Bravo scores were considered success, while PCRs rated Charlie or Delta were considered failure.

---

**Figure 1. Morphology driven preparation design in lower left first molar.**

**Figure 2. Hollow chamfer margin on outer preparation surface.**

All preparation was finished with fine finishing bur (4137F-856-025, Microdont,USA).

All undercuts were blocked with Herculite™ ultra-flow composite (Kerr-Germany, Catalogue no.: 2201-35392).

Full arch Vinylpolysiloxane (EliteHD+, Zermack-Germany, Catalogue no.: F121007 - 2016-05) impression and interocclusal records (Occlufast. Zermack-Germany, Catalogue no.: F121009 - 2016-05) were taken. Provisional restorations were fabricated with Structure-2 bis-composite (Voco-Germany, Catalogue no. VC 84 001479 GB 0918 V) and cemented with temporary cement (Dentotemp-Itena. France, Catalogue no.: K03330 9).

**Laboratory fabrication**

Master models were poured with type IV dental stone (Fujiock-Rock-EP, GC-Belgium, Catalogue no.: 890366), then scanned with an extraoral scanner (Identica-blue. Medit, England).
Blinding
This study was a double-blinded study; both patient and outcomes’ assessors were blinded to the assigned PCR material for each tooth throughout all preparation and clinical evaluation steps. However, the operator wasn’t blinded for purpose of lab communication and ceramic material construction steps.

The blinded assessors were asked to fill a chart for each outcome with the number corresponding to each patient without knowing the PCR material allocated to each side of the mouth for each participant. The template for clinical assessment chart can be found with the trial protocol (Extended data).

Statistical methods
The results were analyzed using IBM SPSS, version 21 (SPSS, Chicago, IL, USA). Chi square test was performed for categorical data, a value of P < 0.05 was considered statistically significant. Sample size (n=23/group) was large enough to detect significant effects and perform pair-wise comparisons with a satisfactory level of power set at 80% and a 95% confidence level.

Results
All 14 patients (8 females and 6 males) attended 6 and 12 month follow-up. A total of 46 PCRs were fabricated in this study. A patient flow diagram is available as part of the Reporting guidelines section.

Survival rates on Kaplan Meier survival curve are provided in (Table 1) and (Figure 3). After 12 months, all PCRs of both groups remained in situ, with a survival-rate of 100% (P=0.8254).

For criteria marginal adaptation, e-max CAD group showed a statistically non-significant decrease in Alpha ratings to 95.65% (p=0.1560), while Vita Suprinity group maintained 100% Alpha scores after 12 months (Table 2, Figure 4 and Underlying data).

For marginal discoloration, e-max CAD group showed a non-significant decrease in Alpha ratings to 95.65 % ( p = 0.1560) after 6 months and 87 % ( p=0.6078) after 12 months (Table 3 and Figure 5).

Bravo ratings of 13% for discoloration and palpable marginal ditching were recorded in e-max CAD group after 12 month (Figure 6–Figure 8), while 4.35% Bravo rating were recorded in the Vita Suprinity group after 12 months.

Discussion
This study aimed to compare the clinical performance of Vita Suprinity and e-max CAD partial coverage restorations in a prospective double-blinded split-mouth design. Selection biases can be avoided in split-mouth studies as the patient acts as their own control, in this way direct comparison of two ceramic materials can be performed.

Compared to full coverage restorations, posterior partial coverage restoration utilizing more tooth structure conservation concept has the potential to reinforce and protect tooth

Table 1. Kaplan-Meier estimate for survival.

| Kaplan-Meier estimate                                      |  |
|-----------------------------------------------------------|--|
| Median survival time (Vita Suprinity)                     | > 50% survival |
| Median survival time (IPS e.max CAD)                      | > 50% survival |
| Confidence interval                                       | 0.4045 - 2.0774 |
| p-value                                                   | 0.8254         |

Table 2. Frequent distribution (%) of marginal adaptation for restorations of both groups at different evaluation time.

| Group         | Base line | 6 months | 12 months | P value |
|---------------|-----------|----------|-----------|---------|
|               | Alpha     | Bravo    | Alpha     | Bravo   |         |
| Vita Suprinity| 23 (100%) | 0 (0%)   | 23 (100%) | 0 (0%)  | 1 ns    |
| IPS e.max     | 23 (100%) | 0 (0%)   | 23 (100%) | 0 (0%)  | 0.3625 ns|

ns; non-significant (p >0.05)
Table 3. Frequent distribution (%) of marginal discoloration for restorations of both groups at different evaluation time.

| Group         | Base line | 6 months | 12 months | P value |
|---------------|-----------|----------|-----------|---------|
|               | Alfa      | Bravo    | Alfa      | Bravo   | Alfa    | Bravo   |         |
| Vita Suprinity| 23 (100%) | 0 (0%)   | 23 (100%) | 0 (0%)  | 22 (95.65%) | 1 (4.35%) | 0.3625 ns |
| IPS e.max     | 23 (100%) | 0 (0%)   | 22 (95.65%) | 1 (4.35%) | 20 (87%) | 3 (13%) | 0.1560 ns |

P value: 1 ns, 0.1560 ns, 0.6078 ns

ns: non-significant (p > 0.05)

Figure 4. Stacked column chart of marginal adaptation associated with restoration for both groups.

Figure 5. Stacked column chart of marginal discoloration associated with restoration for both groups.
structure, preserve enamel, and safeguard pulp vitality while achieving the desired aesthetic results\textsuperscript{5,6}. Overtime, various ceramic materials have been developed for restoring posterior teeth\textsuperscript{7–9}. The excellent combination of high mechanical strength and optical properties of lithium disilicate glass ceramic material made it the gold standard for comparison of new monolithic ceramic materials\textsuperscript{9,11,12}. In our study CAD/CAM lithium disilicate ceramic material (IPS e.max CAD) was selected as the control to compare the clinical outcomes of the newly introduced zirconia-reinforced lithium silicate ceramic material (ZLS) (VITA Suprinity). Reinforced with about 10% zirconium dioxide, ZLS belongs to a new generation of CAD/CAM ceramic that combines positive mechanical characteristics of zirconia with glass-ceramic aesthetic appearance\textsuperscript{22}. Still all findings regarding this new material are either laboratory or initial clinical experience findings\textsuperscript{22–24}. Moreover, the indication for this material should be chosen with strict observation of the material-specific processing instructions regarding the necessary minimum wall thickness and required adhesive luting\textsuperscript{22–23}. All of these findings make it crucial to conduct randomized clinical studies to verify the clinical performance of this new material.

In this study, a novel tooth preparation design; MDPT was selected. According to Venezian M\textsuperscript{25}, this preparation design aims to minimize the loss of healthy tooth tissue and reduce the areas of dentin exposure. A hollow chamfer margin was created on the outer surface of the preparation to optimize the cutting of enamel prisms, thereby bonding and color blending at the transitional zone between tooth and restoration are enhanced\textsuperscript{25–27} (Figure 1), (Figure 2).

In our study, none of PCRs were de-bonded after 12 months. Other studies reported de-bonding of PCRs as one of the
common causes of failure\textsuperscript{13,14}. In those studies, de-bonding mainly was associated with endodontically treated teeth which were among the exclusion criteria in this study.

For marginal adaptation, all PCRs were rated Alpha at base-line and after 6 months. However; after 12 months, palpable margin ditching resulted in Bravo ratings for one of the e.max-CAD PCRs (4.35%). Marginal deterioration might be attributed to degradation of cement due to fatigue in the oral cavity\textsuperscript{15,16}.

Suprinity PCRs sustained Alpha rating after 12 months, which can be attributed to the higher marginal quality and fatigue resistance of zirconia lithium silicate over lithium disilicate as reported by Preis et al.\textsuperscript{23,41}. Nevertheless, results by Elsaka and Elnaghy\textsuperscript{24} were in disagreement with our results as they reported lower brittleness index of e.max CAD compared to Vita Suprinity, and consequently according to the parameters determined by Boccaccini\textsuperscript{44} and Chaysuwan et al.\textsuperscript{45}; e.max CAD might show lower marginal chipping rates than Suprinity\textsuperscript{24}.

Marginal discoloration of e.max PCRs has been reported by Guess et al.\textsuperscript{15,16} and Santos et al.\textsuperscript{37} as the most common clinical finding occurring in 37.5% of PCRs after 7 years.

For marginal discoloration; three of e.max CAD (13%) and one Vita Suprinity (4.35%) restorations showed yellowish marginal staining (Bravo) after 12 months. Still both materials showed clinically acceptable margins.

The null hypothesis for this study was accepted as there was no statistically significant difference in clinical outcomes of the two tested ceramic materials.

Strengths and limitations
This study is randomized clinical trial conducted on relatively big sample size patients, in real clinical settings and was conducted efficiently. This is the first study to compare the clinical performance of e.max CAD and Vita Suprinity partial coverage restorations utilizing a novel preparation design (MDP). Our present study proposes a more conservative and efficient alternative to full coverage restorations for treatment of decayed, vital posterior teeth with high survival rates and excellent marginal quality.

The following limitations should be considered: The morphology driven preparation technique is a new design that wasn’t tested in previous randomized clinical trials before, reliability of the new design irrespective of the ceramic material used needs to be investigated in further clinical trials.

The short follow-up period was one of our study limitations, although no significant differences were found between the two materials, there was notable differences regarding marginal discoloration, thus longer term clinical trials are required to investigate the clinical performance of these ceramic materials.

Conclusion
Both Vita-Suprinity and e.max CAD partial coverage restorations are considered reliable treatment options for restoring larger defects in posterior dentition.

Data availability
Underlying data
Open Science Framework: Clinical Outcomes of Zirconia-reinforced Lithium Silicate Partial Coverage Crowns Compared to Lithium Disilicate Partial Coverage Crowns. A Randomized Controlled Split-mouth Clinical Study. \url{https://doi.org/10.17605/OSF.IO/UNGCJ6}

This project contains the following underlying data:

- Results Data
  - KM curves.xlsx (Kaplein-Meier curves for crown survival)
  - Results raw.xlsx (Performance data for partial coverage crowns used)

Extended data
Open Science Framework: Clinical Outcomes of Zirconia-reinforced Lithium Silicate Partial Coverage Crowns Compared to Lithium Disilicate Partial Coverage Crowns. A Randomized Controlled Split-mouth Clinical Study. \url{https://doi.org/10.17605/OSF.IO/UNGCJ6}

This project contains the following extended data:

- Study Settings
  - Grouping.xlsx (Patient grouping information)
  - ResearchRandomizer.csv (Randomizer results)
- Supplementary files
  - Trial protocol.docx (Trial protocol with copies of all forms used for data collection)

Reporting guidelines
Open Science Framework: CONSORT checklist and flow diagram for ‘Clinical outcomes of zirconia-reinforced lithium silicate partial coverage crowns compared to lithium disilicate partial coverage crowns. A randomized controlled split-mouth clinical study’ \url{https://doi.org/10.17605/OSF.IO/UNGCJ6}

Data are available under the terms of the Creative Commons Zero ‘No rights reserved’ data waiver (CC0 1.0 Public domain dedication).

Consent
Written informed consent for publication of their clinical details was obtained from the patients.

Grant information
The author(s) declared that no grants were involved in supporting this work.
References

1. Stappert CF, Chitmongkolsuk S, Silva NR, et al.: Effect of mouth-motion fatigue and thermal cycling on the marginal accuracy of partial coverage restorations made of various dental materials. Dent Mater. 2008; 24(9): 1248–1257. PubMed Abstract | Publisher Full Text

2. Stappert CF, Guess PC, Chitmongkolsuk S, et al.: All-ceramic partial coverage restorations on natural molars. Masticatory fatigue loading and fracture resistance. Am J Dent. 2007; 20(1): 21–26. PubMed Abstract

3. Machtart J, Chen H, Hamm G, et al.: Buonocore Memorial Lecture. Review of the clinical survival of direct and indirect restorations in posterior teeth of the permanent dentition. Oper Dent. 2004; 29(5): 481–508. PubMed Abstract

4. Lima FF, Neto CF, Rubo JH, et al.: Marginal adaptation of CAD-CAM onlays: Influence of preparation design and impression technique. J Prosthodont. 2018; 12(3): 396–402. PubMed Abstract | Publisher Full Text

5. Edelhoff D, Sorensen JA: Tooth structure removal associated with various preparation designs for posterior teeth. Int J Periodontics Restorative Dent. 2002; 22(3): 241–249. PubMed Abstract

6. Poltano G, Fabianelli A, Papacchini F, et al.: The use of bonded partial ceramic restorations to recover heavily compromised teeth. Int J Esthet Dent. 2016; 11(3): 314–326. PubMed Abstract

7. Holand W, Schweiger M, Watzke R, et al.: Ceramics as biomaterials for dental restoration. Expert Rev Med Devices. 2008; 5(6): 729–745. PubMed Abstract | Publisher Full Text

8. Griggs JA. Recent advances in materials for all-ceramic restorations. Dent Clin North Am. 2007; 51(3): 713–727, vii. PubMed Abstract | Publisher Full Text | Free Full Text

9. Gracis S, Thompson VP, Ferencz JL, et al.: A new classification system for all-ceramic and ceramic-like restorative materials. J Prosthodont. 2015; 24(3): 227–235. PubMed Abstract | Publisher Full Text

10. Donovan TE: Factors essential for successful all-ceramic restorations. J Am Dent Assoc. 2008; 139 Suppl: 145–188. PubMed Abstract | Publisher Full Text

11. Guess PC, Schubbe S, Bonlante EA, et al.: All-ceramic systems: laboratory and clinical performance. Dent Clin North Am. 2011; 55(2): 333–52, ix. PubMed Abstract | Publisher Full Text | Free Full Text

12. Sonnez N, Gutekin F, Turp V, et al.: Evaluation of five CAD/CAM materials by microstructural characterization and mechanical tests: a comparative in vitro study. BMC Oral Health. 2018; 18(1): 5. PubMed Abstract | Publisher Full Text | Free Full Text

13. Kämér N, Frankenberger R. Clinical performance of bonded leucite-reinforced glass ceramic inlays and onlays after eight years. Dent Mater. 2005; 21(3): 262–271. PubMed Abstract | Publisher Full Text

14. Murguio R, Bernal G: Three-year clinical follow-up of posterior teeth restored with leucite-reinforced IPS empress onlays and partial veneer crowns. J Prosthodont. 2012; 21(5): 340–345. PubMed Abstract | Publisher Full Text

15. Guess PC, Stub Jr, Steinhart N, et al.: All-ceramic partial coverage restorations– midterm results of a 5-year prospective clinical splitmouth study. J Dent. 2009; 37(6): 627–637. PubMed Abstract | Publisher Full Text

16. Guess PC, Seil CF, Steinhart YN, et al.: Prospective clinical split-mouth study of pressed and CAD/CAM all-ceramic partial-coverage restorations: 7-year results. Int J Prosthodont. 2013; 26(1): 21–25. PubMed Abstract | Publisher Full Text

17. Santos MJ, Freitas MC, Azvedo LM, et al.: Clinical evaluation of ceramic inlays and onlays fabricated with two systems: 12-year follow-up. Clin Oral Investig. 2016; 20(7): 1659–1667. PubMed Abstract | Publisher Full Text

18. Wolfart S, Eschbach S, Sherher S, et al.: Clinical outcome of three-unit lithium disilicate glass-ceramic fixed dental prostheses: up to 8 years results. Dent Mater. 2009; 25(6): e63–71. PubMed Abstract | Publisher Full Text

19. Fastbinder DJ, Denison JB, Heys D, et al.: A clinical evaluation of chairside lithium disilicate CAD/CAM crowns: a two-year report. J Am Dent Assoc. 2010; 141 Suppl 2: 105–14S. PubMed Abstract | Publisher Full Text

20. Peger S, Salmon A, Bidra AS. Clinical outcomes of lithium disilicate single crowns and partial fixed dental prostheses: a systematic review. J Prosthod Dent. 2014; 112(1): 22–30. PubMed Abstract | Publisher Full Text

21. Van den Bremmer CP, Winkenborg C, van Peit H, et al.: The Clinical Performance of Monolithic Lithium Disilicate Posterior Restorations After 5, 10, and 15 Years: A Retrospective Case Series. Int J Prosthodont. 2017; 30(1): 62–65. PubMed Abstract | Publisher Full Text

22. Traini T, Sinjari B, Pacetta R, et al.: The zirconia-reinforced lithium silicate ceramic: lights and shadows of a new material. Dent Mater. 2016; 35(5): 748–755. PubMed Abstract | Publisher Full Text

23. Preis V, Behr M, Hahnel S, et al.: Influence of cementation on in vitro performance, marginal adaptation and fracture resistance of CAD/CAM fabricated ZLS molar crowns. Dent Mater. 2018; 34(11): 1363–1369. PubMed Abstract | Publisher Full Text

24. Elsaka SE, Elnaghy AM: Mechanical properties of zirconia reinforced lithium silicate glass-ceramic. Dent Mater. 2016; 32(7): 908–914. PubMed Abstract | Publisher Full Text

25. Veneziani M: Posterior indirect adhesive restorations: updated indications and the Morphology Driven Preparation Technique. Int J Esthet Dent. 2017; 12(2): 204–230. PubMed Abstract

26. Magne P, Spreafico RC: Deep margin elevation: a paradigm shift. Am J Esthet Dent. 2012; 2: 86–96. Reference Source

27. Veneziani M: Adhesive restorations in the posterior area with subgingival cervical margins: new classification and differentiated treatment approach. Eur J Esthet Dent. 2010; 5(1): 50–76. PubMed Abstract

28. Bayne SC, Schmalz G: Reprinting the classic article on USPS evaluation methods for measuring the clinical research performance of restorative materials. Clin Oral Investig. 2005; 9(4): 209–214. PubMed Abstract | Publisher Full Text | Free Full Text

29. Ryge G: Clinical criteria. Int Dent J. 1980; 30(4): 347–358. PubMed Abstract

30. Cvar JF, Ryge G: Reprint of criteria for the clinical evaluation of dental restorative materials. 1971, Clin Oral Investig. 2000; 9(4): 215–232. PubMed Abstract | Publisher Full Text

31. Moncada G, Silva F, Angel P, et al.: Evaluation of dental restorations: a comparative study between clinical and digital photographic assessments. Oper Dent. 2014; 39(2): E44–50. PubMed Abstract | Publisher Full Text

32. Arusuave Kj: Standardizing failure, success, and survival decisions in clinical studies of ceramic and metal-ceramic fixed dental prostheses. Dent Mater. 2012; 28(1): 102–111. PubMed Abstract | Publisher Full Text | Free Full Text

33. Pjetursson BE, Sailer I, Zwahlen M, et al.: A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part I: Single crowns. Clin Oral Implants Res. 2007; 18 Suppl 3: 73–85. PubMed Abstract | Publisher Full Text

34. Arusuave KJ, Kakar K, Ferres N: Which mechanical and physical testing methods are relevant for predicting the clinical performance of ceramic-based dental prostheses? Clin Oral Implants Res. 2007; 18 Suppl 3: 218–31. PubMed Abstract | Publisher Full Text

35. Araujo NS, Moda MD, Silva EA, et al.: Survival of all-ceramic restorations after a minimum follow-up of five years: A systematic review. Quintessence Int. 2016; 47(5): 395–405. PubMed Abstract | Publisher Full Text

36. Nassar H, Halim CH, Katamish HA: Clinical Outcomes of Zirconia-reinforced Lithium Silicate Partial Coverage Crowns Compared to Lithium Disilicate Partial Coverage Crowns. A Randomized Controlled Split-mouth Clinical Study. 2019. http://www.l10.17605/OSF.IO/UNGCJ

37. Pandis N, Walsh T, Polychronopoulou A, et al.: Split-mouth designs in orthodontics: an overview with applications to orthodontic clinical trials. Eur J Orthod. 2013; 35(6): 783–9. PubMed Abstract | Publisher Full Text

38. Lesaffre E, Garcia Zattera MJ, Redmond C, et al.: Reported methodological quality of split-mouth studies. J Clin Periodontol. 2007; 34(9): 756–1. PubMed Abstract | Publisher Full Text

39. Lesaffre E, Philstrom B, Needleman I, et al.: The design and analysis of split-mouth studies: what statisticians and clinicians should know. Stat Med. 2009; 28(28): 3470–82. PubMed Abstract | Publisher Full Text

40. Bell R, Petchell A, Hofner B, et al.: Fracture Rates and Lifetime Estimations of CAD/CAM All-ceramic Restorations. J Dent Res. 2016; 95(1): 67–73. PubMed Abstract | Publisher Full Text

41. Sulaiman TA, Delgado AJ, Donovan TE: Survival rate of lithium disilicate restorations at 4 years: A retrospective study. J Prosthodont. 2015; 114(3): 364–6. PubMed Abstract | Publisher Full Text

42. Morimoto S, Rebelo de Sampaio FB, Braga MM, et al.: Survival Rate of Resin and...
43. Preis V, Hahnel S, Behr M, et al.: In-vitro fatigue and fracture testing of CAD/CAM-materials in implant-supported molar crowns. Dent Mater. 2017; 33(4): 427–433. PubMed Abstract | Publisher Full Text

44. Boccaccini AR: Machinability and brittleness of glass-ceramics. J Mater Process Tech. 1997; 65(1–3): 302–304. Publisher Full Text

45. Chaysuwan D, Sirinukumwattana K, Kanchanatarewat K, et al.: Machinable glass-ceramics forming as a restorative dental material. Dent Mater J. 2011; 30(3): 358–67. PubMed Abstract | Publisher Full Text
Thank you for inviting me to review this research article addressing a very important topic, clinical outcome of all ceramic partial coverage restorations, and the article is well-written. I agree with the authors that this study has a number of strengths (a randomized, split mouth study). However, I have some concerns about the design and the interpretation of the results that I believe should be addressed to make the paper stronger.

The title
It could be better to consider the following title for your study: "Clinical outcome of CAD/CAM all-ceramic partial-coverage restorations: A Prospective clinical split-mouth study".  

Abstract
Regarding the abstract section it’s informative.

Introduction section
- Is short and the rationale of the study is not well presented, kindly add a short review about the previous clinical studies about all ceramic partial coverage restoration focusing in the preparation design, the cause of the use such design, and why in your study you use morphology driven preparation from biomechanical prospective.

Method section
- Regarding to tooth preparation, Kindly specify the following:
  - Cavity depth, cavity width (BL) in both premolar and molar.
  - The buccal and lingual extension of the interproximal box walls.
  - Regarding to the sentence, all undercuts were blocked....kindly, explain.

- Regarding to clinical outcome:
  - Each restoration was examined by one or two assessors? Kindly specify.
  - Although, 12 months of clinical service is too short period to assess the survival rate of the restoration as mentioned by the authors in the study limitation section, the finding could be considered as a preliminary finding.
Results section
○ Kindly, add a table of restoration distribution, for example, how many molars, premolars, and their frequency distribution.

○ Is there any patient drop out during the evaluation period or not, kindly add this part.

Discussion section
○ Your null hypothesis is accepted or rejected? And why? Kindly discuss.

○ The second paragraph in the discussion section, is fitted best to your introduction section, as it describe your study rationale.

References
1. Guess PC, Selz CF, Steinhart YN, Stampf S, et al.: Prospective clinical split-mouth study of pressed and CAD/CAM all-ceramic partial-coverage restorations: 7-year results. Int J Prosthodont. 26 (1): 21-5 PubMed Abstract | Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Prosthetic dentistry, Dental Biomaterial, Clinical Trials.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.
Oliver Schierz  
Department of Prosthodontics and Materials Science, University of Leipzig, Leipzig, Germany

- The article contains 12 month results of a randomized clinical trial in partial crowns using two different dental ceramics.
- The title does match the content of the publication.
- The keywords are appropriate.
- The introduction is very short.
- The paper is linguistically sufficiently written and structured. Sample size calculation is insufficient, calculating for surface roughness, a parameter not reported and potentially secondary aim at best. This caused a severe miscalculation in number of patients needed to answer the scientific question, reflected by insignificant p-values in the results.
- According to material and methods each participant receives 2 crowns, one of ZLS and one LiS. When 14 participants are included this should result in 28 crowns, not 46. This difference should be explained and is probably due to more than one pair of partial crowns in each participant.
- The time frame of 12 months follow-up is much too short to find differences in respect that known clinical survival within 5 years is up 98 percent.
- A report about the distribution of included restorations in premolars and molars is missing.
- With the current number of participants the scientific value is low.

Is the work clearly and accurately presented and does it cite the current literature?  
Yes

Is the study design appropriate and is the work technically sound?  
Yes

Are sufficient details of methods and analysis provided to allow replication by others?  
No

If applicable, is the statistical analysis and its interpretation appropriate?  
No

Are all the source data underlying the results available to ensure full reproducibility?
Yes

**Are the conclusions drawn adequately supported by the results?**
No

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Prosthetic dentistry, clinical studies

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

---

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f100.com