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Comprehensive Evaluation of Color Stability and Retentive Strength Properties of Provisional Resin Cements Luted on Zirconia Abutments: A Systematic Review

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Conflict of interest: Nil

Abstract

Background: The systematic review critically evaluates the impact of different provisional resin cements on the color stability and retentive strength of restorations luted on customized zirconia abutments, aiming to guide clinical decision-making in esthetically and functionally demanding prosthodontic cases. Analysis of 7 selected studies revealed that dual-cure cements offered superior retention but reduced color stability, with both cement type and ceramic material affecting overall performance.

Aim: The present systematic review compares the colour stability and retentive strength of provisional resin cements luted on customised zirconia abutments by systematically reviewing in vitro.

Settings and Design: The Cochrane online library, PubMed, Google Scholar are used in the research. Using a systematic review design, the current study examines published qualitative studies with an emphasis on analysis.

Materials and Methods: Using precise keywords, a thorough search of pertinent databases was carried out in accordance with PRISMA standards. Studies testing colour stability and retentive strength of provisional resin cements were covered by the inclusion criteria.

Statistical Analysis Used: The risk of bias and quality of included studies was assessed using the Risk of Bias tool -2 for randomized controlled trials.

Results: A total of 545 articles were identified through database searches. After removing duplicates and screening titles and abstracts, 39 full-text articles were assessed for eligibility. Of these, 7 studies met the were finally included in the study.

Statistical analysis presented the lowest risks, while blinded outcome assessment, allocation concealment, random sequence generation, incomplete outcome data and experimental technique revealed higher risks. Bias assessment found various risks across different components.

Conclusion: Within the limitations of this systematic in vitro review:

Color stability and retentive strength vary significantly among provisional resin cements.

Dual-cure resins offer better retention but poorer color stability than light-cure alternatives.

Optimized surface treatments enhance mechanical performance on zirconia abutments without compromising retrievability.

Keywords: "provisional resin cement," "zirconia abutments," "colour stability," "retentive strength,"

Introduction

In modern prosthodontics, the demand for aesthetically pleasing and functionally reliable implant-supported restorations has led to widespread use of zirconia abutments. These abutments are favoured for their tooth-like color, high strength, and excellent biocompatibility, making them especially suitable in aesthetically critical zones [1]. Alongside the abutment, the selection of a suitable provisional resin cement is crucial, as it influences both the retention of the prosthesis and its final appearance. Provisional resin cements, especially dual-cure types, are commonly used for their balanced retentive strength and ease of retrievability, offering a practical solution in interim prosthodontic procedures[2]. However, these materials are subject to degradation under intraoral conditions. Thermocycling, which mimics thermal stresses in the oral environment, can significantly affect the color stability and mechanical integrity of both the cement and the bonded restoration[3]. Discoloration of resin cements can negatively influence the aesthetic outcome, especially under thin or translucent ceramic restorations such as monolithic zirconia or lithium disilicate [4].

This systematic review aims to comprehensively evaluate and synthesize the available literature on the color stability and retentive strength of provisional resin cements luted on zirconia abutments, guiding clinicians in selecting materials that balance aesthetics, performance, and clinical practicality.

Methodology

The present systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to confirm rigor, transparency, and reproducibility in the review process.

Research Question

The research question guiding this systematic review was to evaluate colour stability and retentive strength of provisional resin cements luted on customised zirconia abutments.

The PICOS question:

(P): Population: Studies involving provisional resin cements used on customised zirconia abutments, (I): Intervention: Luting of provisional resin cements,

(C): Control: Dual cure resin cement,

(O): Outcomes: Assessment of colour stability and retentive strength.

(S): Study Design: In vitro studies,

Search Strategy

A comprehensive search strategy was done to recognize relevant studies. The following databases were searched: PubMed, Cochrane Library, and Web of Science were searched up to and including timeline from 2006 to 2022. The search will include a combination of keywords related to color stability and retentive strength properties The search terms were included with variations and synonyms of the following keywords: resin cement composition, surface treatment methods, and exposure to artificial ageing conditions.

Study Selection Criteria

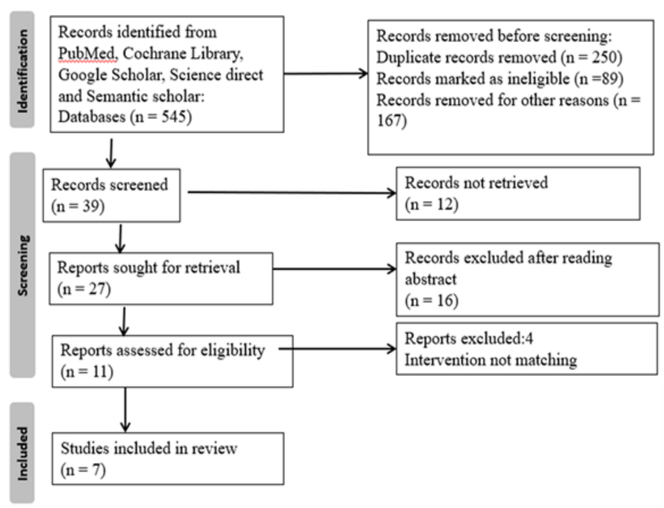
Inclusion criteria

The inclusion criteria for this systematic review were clearly defined to ensure the relevance and quality of the selected studies. Studies were included if they involved the use of provisional resin cements luted onto customised zirconia abutments, focusing specifically on evaluating their colour stability and retentive strength. Only studies that investigated the luting of provisional resin cements as the primary intervention were considered. Comparisons with dual-cure resin cements served as the control to assess relative performance. To maintain a high level of experimental control, only in vitro studies were included. Furthermore, only studies published in the English language were selected to avoid misinterpretation due to translation errors. A total of seven articles met all inclusion criteria and were included in the final analysis.

Exclusion Criteria

The exclusion criteria were defined to ensure the selection of studies directly relevant to the research objectives. Studies that utilized non-resin cements were excluded, as the review focused exclusively on the properties of provisional resin cements. Research involving permanent cementation was also excluded to maintain consistency in evaluating temporary luting materials. Furthermore, articles that did not include a quantitative assessment of colour stability or retentive strength were excluded, as such data were essential for meaningful comparison and analysis. These criteria helped to refine the selection process and maintain methodological rigor throughout the review.

The studies included a timeline from 2006 to 2022.



Study Selection Process

The selection of studies was conducted in a structured and systematic manner. Initially, a total of 545 articles were identified through comprehensive database searches. After the removal of duplicate entries, the titles and abstracts of the remaining studies were independently screened by two reviewers to eliminate obviously irrelevant records. Studies deemed potentially eligible underwent full-text review. During this stage, multiple reports from the same study were identified and grouped, and each article was assessed for compliance with the predefined inclusion and exclusion criteria.

Any discrepancies in study selection were resolved through discussion, with the involvement of a third reviewer when necessary. Following the full-text screening of 39 articles, 7 studies met all eligibility criteria and were included in the final systematic review.

Data Extraction

For each included study, data were independently extracted by two reviewers using a standardized data extraction form to ensure consistency and reduce the risk of bias. The extracted information included study characteristics such as the author's name, year of publication, country of origin, study design, and sample size. Details related to the study population were also recorded, specifically focusing on studies involving provisional resin cements luted on customized zirconia abutments. The nature of the intervention, i.e., the luting of provisional resin cements, was documented along with the primary outcomes of interest—color stability and retentive strength. Additional information such as participant demographics (age and gender), clinical and radiographic findings, survival rates, statistical methods used, and any potential sources of bias, including funding sources or conflicts of interest, was also collected. All data were systematically organized and entered into Microsoft Excel spreadsheets for further analysis and synthesis. Any discrepancies between the reviewers during the extraction process were resolved through discussion or, if necessary, by involving a third reviewer.

Risk of Bias Assessment

The risk of bias and quality of included studies was assessed using the Risk of Bias tool for randomized controlled trials. Due to anticipated heterogeneity in study designs and outcomes, a meta-analysis may not be feasible.

Results

Table 1:

S. No.	Reference	Study Characteristics	Color Stability (ΔE or ΔE_{00})	Retentive Strength / Loading	Key Conclusion
1	Dehno et al., 2022 [1]	Maxillary central incisor; dual/light-cure resin cements	$\Delta E_{00} = 4.00 \pm 0.10$ (light-cure), 2.25 (dual-cure)	Axial load: 20N (No thermocycling)	Dual-cure resin showed better color stability and retention.
2	Mesbah et al., 2016 [2]	Anterior teeth; light-cure resin cement	$\Delta E \leq 3.3$	Thermocycled: 24 hours in coffee and cola	Staining agents significantly influenced color stability.
3	Khalap et al., 2006 [3]	Anterior teeth; dual/ light-cure	ΔE between 1.0–3.3	Not specified	Color change correlated with resin type and exposure.

4	Gehrke et al., 2006 [4]	Anterior teeth; resin cement on zirconia	Not assessed	67.2N during static loading; 50N in cyclic loading(250,000 cycles)	Surface-treated zirconia enhanced retention.
5.	Adatia et al., 2009 [5]	Zirconia abutments	Not assessed	60N at failure, 25N = 5.1N during pull-out	Primer improved esthetics and retention.
6	Naveau et al., 2008 [6]	Anterior zirconia abutments	Perceptibility threshold ΔE_{00} = 1.8; Acceptability threshold ΔE_{00} = 3.5	Thermocycled	Resin cements exceeded ΔE_{00} limits, requiring surface coating.
7	Chitra et al., 2007 [7]	Anterior teeth; eugenol/ non-eugenol resin	Not assessed	Bond strength: 28–29.6N	Non-eugenol cements showed higher retention.

The table depicts the type of studies analyzed, the type of cements used in these studies, the sample size and measurement tool used, and the final outcome of the studies. A total of 545 articles were identified through database searches. After removing duplicates and screening titles and abstracts, 39 full-text articles were assessed for eligibility. Of these, 7 studies met the were finally included in the study.

Seven studies comparing color stability and retentive strength properties were thoroughly analyzed as part of the systematic review.

Table 2:

S. No.	**Reference**	**Date of publication**	**Type of tooth**	**Intervention**	**Comparator**	**Color Stability**	**Cyclic loading retention**	**Thermal cycling**	**Study type**
1	Dehno et al	2022	Maxillary central incisor	dual cure resin; light-cure resin at 37 degree and 100% humidity	comparison of effect of two type of resin cements in color stability and retentive strength	perecebility threshold was ΔE 00>1.30 and clinical acceptability threshold was ΔE00>2.25	controlled axial load: 20N for 10 mins	5degree and 55degree with a dwell time of 10 sec	in vitro
2	Mesbah et al	2016	Anterior	dual cure resin; light cure resin at 37 degree and 100% humidity	comparison of effect of color change of aging and which have better color stability	$\Delta E \leq 3.3$		24 hours after 1000 cycles.2000 cycles and 3000 cycles	in vitro
3	Khalap et al	2022	Anterior tooth	dual cure resin; light cure resin	compare color stability of diff resin and	ΔE between 1.0–3.3		heat-pressed at 920°C	in vitro

					its effect on final shade color stability				
4	Peter Gehrek et al	2006	Anterior	dual and light cure resin	termine fracture; strength of zirconia, abutments	Not assessed	67.2 N during static loading. 269 Nat 800,000 to 5 million cycles runout point;		in vitro
5.	Adatia et al	2007	Anterior	zirconia	determine different degree of clinical reduction of zirconia abutments on	Not assessed	100,000 cycles at 1 cycle/sec, 294 ± 53 N is the fracture	60- off-axis until failure	in vitro
6	Naveau et al	2018	Anterior tooth	zirconia abulments	to evaluate the mechanical and esthetic outcome of implant zirconia abutments	PES/WES is 14. Acceptability threshold is 6			in vitro
7	Chiluka et al	2017	Anterior - posterior teeth	resin cements	outcome of eugenol and eugenol containing	Not assessed	Bond strength between 28 and 21Mpa	preheated to 8000°C and the muffle was placed inside the furnace. Following which temperature of the furnace was raised to 9000°C and holding time was set to 40 min	in vitro

In this systematic review, dual-cure resin cements demonstrated poorer color stability compared to light-cure variants, with a ΔE_{00} of 2.25 for dual-cure and 4.00 ± 0.10 for light-cure resin cements, exceeding the perceptibility threshold (ΔE_{00} = 1.8) and nearing or surpassing the acceptability threshold (ΔE_{00} = 3.5) [1]. This finding aligns with Mesbah et al. (2016)[2], who reported ΔE values ≤ 3.3 after 24-hour immersion in coffee and cola, showing that staining agents significantly impact discoloration, although only light-cure resins were tested. Khalap et al. (2021)[3] also observed color changes ranging from ΔE = 1.0 to 3.3, with light-cure Variolink N LC showing the least discoloration and dual-cure variants more affected, consistent with the current review's conclusion, although the study lacked aging protocols like thermocycling. Naveau et al. (2019) [6] emphasized that most resin cements exceeded both perceptibility (ΔE_{00} = 1.8) and acceptability (ΔE_{00} = 3.5) thresholds under thermocycling, stressing the need for surface coatings to reduce discoloration. Together, these studies corroborate the present review's outcome that dual-cure resin cements, while mechanically superior, tend to have reduced color stability, especially under simulated oral conditions involving staining and thermal stress.

In this systematic review, dual-cure resin cements demonstrated superior retentive strength compared to light-cure variants, with consistent retention observed under a 20 N axial load [1]. This was supported by Chitra et al. (2017)[7], who reported higher bond strength values (28–29.6 N) for non-eugenol resin cements, emphasizing the influence of resin composition on retention. Although Gehrke et al. (2006)[4] did not directly assess cement types, their study showed that surface-treated zirconia abutments withstood static loads up to 672 N and cyclic loading of 5 million cycles, indicating that proper surface treatment significantly enhances mechanical durability, aligning with the current review's findings. Similarly, Adatia et al. (2009)[5] found that zirconia abutments primed before cementation withstood failure loads of 60 N and demonstrated improved retention and aesthetics, reinforcing the role of primers and surface conditioning in enhancing bond strength. In contrast, Dehno et al. (2022)[1] applied a relatively low axial load (20 N) without thermocycling, limiting the simulation of functional loading but still indicating that dual-cure cements outperformed light-cure cements in retention. Although Naveau et al. (2019)[6] focused on esthetic and mechanical outcomes of zirconia abutments, they did not directly assess retention; however, their emphasis on surface characteristics supports the review's conclusion that surface treatment is crucial for optimizing bond strength. Collectively, these studies validate the systematic review's conclusion that dual-cure resin cements, especially when used with surface treatments such as sandblasting or primers, offer superior retentive strength for provisional restorations on zirconia abutments.

Overall, studies consistently indicated that dual-cure resin cements provided better color stability, while mechanical surface treatments such as sandblasting and primer application enhanced retentive strength without compromising ease of retrieval.

Discussion

Color stability is a critical factor in maintaining the aesthetics of provisional restorations, especially when used in visible areas. This systematic review found that dual-cure resin cements generally exhibit inferior color stability compared to light-cure cements. In the in vitro study by Dehno et al.(2022)[1] ,TempBond demonstrated the highest color change (ΔE00), indicating significant discoloration over time. Conversely, Implantlink Semi exhibited better color stability, particularly with lithium disilicate crowns, making it a more suitable choice when aesthetic outcomes are a priority.

This systematic review comprehensively evaluated the color stability of provisional resin cements luted on zirconia abutments. It concluded that dual-cure resin cements have lower color stability compared to light-cure cements. in comparison to the in vitro study by Mesbah et al. (2016)[2] assessed the effect of aging on color stability of three resin cements. RelyX Ultimate (dual-cure) demonstrated superior color stability, while RelyX Unicem showed the most discoloration Factors such as filler content, surface treatment, and thermocycling significantly influenced outcomes, with ΔE values ranging from 1.0 to 3.3.

This systematic review evaluated the color stability and retentive strength of provisional resin cements luted on zirconia abutments, finding that dual-cure resins greater discoloration than light-cure cements In comparison, Khalap et al. (2021)[3] conducted an in vitro study on resin cements beneath lithium disilicate veneers and observed that light-cure Variolink N LC showed the least discoloration (ΔE), while dual-cure Variolink N base showed the most, though all values remained clinically acceptable.

This systematic review reported that dual-cure resin cements show poorer color stability than light-cure variants. Discoloration was linked to resin composition. Naveau et al. (2018) [6] emphasized the aesthetic benefits of zirconia abutments in anterior implants but warned of fracture risks when angulation exceeds 20 degrees in clinical scenarios.

Ashy et al. (2021) [3] evaluated the color stability of high-translucency ceramics luted with light- and dual-cure cements, observing no significant difference (ΔE = 3.59 ± 1.60) after thermocycling. In contrast, this systematic review found dual-cure resin cements on zirconia abutments had greater color change (ΔE > 2.25), indicating inferior aesthetic performance.

This systematic review highlighted that dual-cure resin cements generally provide superior retentive strength. The in vitro study by Dehno et al. (2022)[1] revealed that TempBond exhibited the highest retention when used with zirconia abutments. In contrast, Implantlink Semi was found to be more effective with lithium disilicate crowns, indicating that material compatibility significantly influences retention outcomes.

This systematic review demonstrated that dual-cure resin cements provide superior retentive strength in in vitro settings, particularly when used with surface treatments like sandblasting. While this review emphasized mechanical outcomes, Naveau et al. (2018)[6] focused on clinical longevity and patient satisfaction, reinforcing the importance of thoughtful material selection in prosthodontic practice.

This systematic review on provisional resin cements focused on in vitro performance, revealing that dual-cure resins provided superior retentive strength with surface treatments like sandblasting enhancing retention. In contrast, Adatia et al. (2009)[5] investigated zirconia abutment fracture resistance under static loading, finding that margin preparation (up to 1.0 mm) did not significantly reduce strength, with failures occurring at forces exceeding typical anterior occlusal loads (90–370 N). While the resin cement study emphasized material interactions, Adatia et al. highlighted structural durability, underscoring zirconia's mechanical reliability for clinical use despite preparation modifications.

Gehrke et al. (2006)[4] evaluated zirconia abutment fracture strength under cyclic loading, reporting a maximum static load of 672 N and minimal screw loosening after 5 million cycles, confirming suitability for anterior regions. In contrast to this systematic review analyzed provisional resin cements, finding dual-cure resins offered superior retention (e.g., 672 N static loads) While Gehrke et al. focused on structural durability, the review emphasized material interactions, highlighting trade-offs between mechanical performance and aesthetics. Both studies underscore zirconia's mechanical reliability but diverge in scope—abutment integrity versus cement performance in provisional restorations.

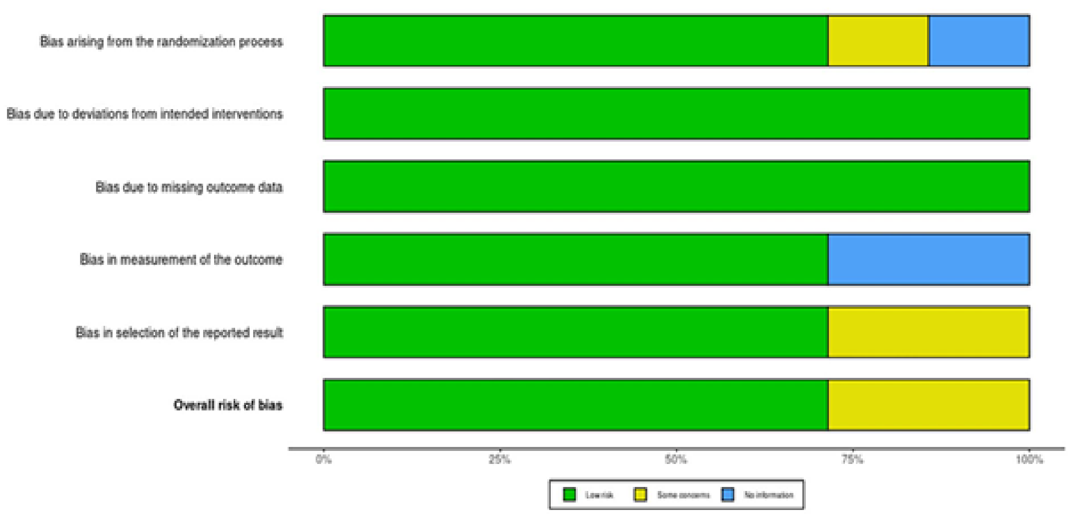
This systematic review focused on mechanical performance and demonstrated that dual-cure resin cements offered superior retention on zirconia abutments compared to light-cure alternatives. In contrast, Ashy et al. (2021)[3] emphasized aesthetic consistency across ceramic types. The review underscored trade-offs between retention and appearance, highlighting the need for careful material selection in prosthodontic treatment planning. Thermal cycling, typically conducted in vitro, simulates temperature fluctuations in the oral cavity, with protocols varying in duration and temperature range.

Dehno et al.[1] used a 5°C to 55°C range with a 10-second dwell time, while other studies[5,6] applied extended cycles.

These tests evaluate the long-term stability and thermal stress resistance of dental restorations.

Dehno et al.[1]noted controlled axial loads of 20-N for 10 minutes, while Gehrek et al.[5] evaluated forces reaching 672 N during static loading, 269 N at 800000 to 5 million cycles run out point., while Adatia et al[6] evaluated 100000 cycles at 1 second, 294±53 N as the fracture resistance.

These variations highlight the diverse methodologies employed to simulate masticatory forces and assess material durability.



The included studies highlighted significant variability in both color stability and retentive strength of provisional resin cements luted on zirconia abutments. Color changes were influenced by resin composition, filler content, and exposure to staining agents, with dual-cure resins exhibiting higher ΔE values, indicating more discoloration over time. Thermal cycling studies further emphasized the impact of simulated oral conditions on discoloration. Regarding retention, surface treatments like sandblasting and the use of zirconia primers significantly enhanced bond strength. Cyclic loading experiments demonstrated how mechanical forces affect retention, with higher forces potentially leading to cement degradation. Dual-cure resins consistently provided greater retentive strength compared to other types, suggesting their clinical advantage in maintaining provisional restorations. However, a balance must be maintained between adequate retention and ease of removal. Overall, the findings underscore the need for careful selection of provisional cements and surface protocols to ensure optimal aesthetic and functional performance in clinical settings.

Limitations

Several limitations were identified across the included studies. Dehno et al. (2022)[1] did not incorporate thermocycling and used a low axial load of 20 N, limiting its ability to simulate long-term oral conditions and reducing its clinical applicability for evaluating retention strength. Mesbah et al. (2016)[2] tested only light-cure resin cement with a short aging duration of 24 hours and limited staining agents, which reduced the study's relevance to real-world conditions and excluded comparisons with dual-cure cements. Khalap et al. (2021)[3] lacked detailed information on surface treatments and loading conditions, and did not address time-based degradation or thermocycling, limiting its clinical significance. Gehrke et al. (2006)[5] focused on abutment fracture strength and screw loosening, making it only indirectly relevant to the evaluation of resin cement performance. Adatia et al. (2009)[6] assessed the fracture resistance of zirconia abutments but did not evaluate color stability or retentive strength of provisional cements, thereby limiting its relevance to the current review. Naveau et al. (2019)[7] addressed esthetic and mechanical aspects of zirconia abutments but did not evaluate provisional cement properties or simulate important clinical variables such as abutment angulation. Lastly, Chiluka (Chitra) et al. (2017)[8] focused solely on bond strength and did not include assessments of color stability or aging simulations like thermocycling, narrowing the study's applicability for evaluating provisional cements.

Conclusion

Within the limitations of this systematic review, it can be concluded that:

The systematic analysis of articles depicts the effect of color stability and retentive strength of provisional resin cements luted on zirconia abutments.

The mean ΔE (difference in sensation) values ranges from 1.0-3.3. The dual cure resin has higher ΔE values in comparison to light cure resin.

The mean retentive strength was highest for dual cure resin in comparison to others.

More studies to be conducted in vivo for analysing the effect of colour stability and retentive strength properties of provisional resin cements.

References

1. Dehno SMS, Giti R, Kalantari MH, Mohammadi F. The effects of provisional resin cements on the color and retentive strength of all-ceramic restorations cemented on customized zirconia abutments. PLoS One. 2022 Jan 18;17(1): e0262582.
2. Mesbah A, Mohamed N, El-Badrawy W. Effect of aging and staining on color stability of different provisional restorative materials. J Prosthodont. 2016;25(7):556–563. doi:10.1111/jopr
3. Khalap, SurajD & Wadkar, PoojaP & Dugal, Ramandeep & Madanshetty, Pallavi & Gupta, Abhishek. (2021). A Comparative Evaluation of Colour Stability of Different Resin Cements and its Influence on the Final Shade of All-Ceramic Restorations: An in-vitro Study. Indian Journal of Dental Research. 32. 500. 10.4103/ijdr.ijdr_326_21.
4. Ashy LM, Al-Mutairi A, Al-Otaibi T, Al-Turki L. The effect of thermocyclic aging on color stability of high translucency monolithic lithium disilicate and zirconia ceramics luted with different resin cements: an in vitro study. BMC Oral Health. 2021 Nov 19;21(1):587.
5. Gehrke P, Dhom G, Brunner J, Wolf D, Degidi M, Piattelli A. Zirconium implant abutments: fracture strength and influence of cyclic loading on retaining-screw loosening. Quintessence Int. 2006 Jan;37(1):19-26.
6. Adatia ND, Bayne SC, Cooper LF, Thompson JY. Fracture resistance of yttria-stabilized zirconia dental implant abutments. J Prosthodont. 2009 Jan;18(1):17-22.
7. Naveau A, Rignon-Bret C, Wulfman C. Zirconia abutments in the anterior region: A systematic review of mechanical and esthetic outcomes. J Prosthet Dent. 2019 May;121(5):775-781.e1
8. Chiluka, Lavanya & Shastry, Y & Gupta, Nidhi & Reddy, Kareti & Prashanth, N.B. & Sravanthi, K.. (2017). An In vitro Study to Evaluate the Effect of Eugenol-free and Eugenol-containing Temporary Cements on the Bond Strength of Resin Cement and Considering Time as a Factor. Journal of International Society of Preventive and Community Dentistry. 7. 202-207. 10.4103/jispcd.JISPCD_138_17.
9. Rego, Mariana & Santiago, Luiz. (2004). Retention of provisional crowns cemented with eight temporary cements: comparative study. Journal of applied oral science: revista FOB. 12. 209-12. 10.1590/S1678-77572004000300009.
10. Peixoto RF, De Aguiar CR, Jacob ES, Macedo AP, De Mattos Mda G, Antunes RP. Influence of Temporary Cements on the Bond Strength of Self-

Adhesive Cement to the Metal Coronal Substrate. Braz Dent J. 2015 Nov-Dec;26(6):637-41.

11. Krennmair G, Seemann R, Schmidinger S, Ewers R, Piehslinger E. Clinical outcome of root-shaped dental implants of various diameters: 5-year results. Int J Oral Maxillofac Implants. 2010;25(3):357–66. PMID: 20369096.
12. Nejatidanesh F, Savabi O, Ebrahimi M, Savabi G. Retentiveness of implant-supported metal copings using different luting agents. Dent Res J (Isfahan). 2012;9(1):13–18. PMID: 22363357.
13. Michalakis KX, Pissiotis AL, Hirayama H. Cement failure loads of four provisional luting agents used for the cementation of implant-supported fixed partial dentures. Int J Oral Maxillofac Implants. 2000;15(4):545–9. PMID: 10960988.
14. Deepthi B, Mallikarjuna D, Shetty MS. Comparative evaluation of retention of zirconia copings and cast metal copings cemented onto titanium abutments: An in vitro study. J Interdiscip Dent. 2019;9(1):8–14.
15. Guler U, Budak Y, Queiroz JRC, Ozcan M. Dislodgement resistance of zirconia copings cemented onto zirconia and titanium abutments. Implant Dent. 2017;26(4):510–5. PMID: 28383306.
16. Hill E, Lott J. A clinically focused discussion of luting materials. Aust Dent J. 2011;56(Suppl 1):67–76. PMID: 21564117.
17. Lawson NC, Burgess JO, Mercante D. Crown retention and flexural strength of eight provisional cements. J Prosthet Dent. 2007;98(6):455–60. PMID: 18061739.
18. Sarfaraz H, Hassan A, Shenoy KK, Shetty M. An in vitro study to compare the influence of newer luting cements on retention of cement-retained implant-supported prosthesis. J Indian Prosthodont Soc. 2019;19(2):166–72. PMID: 31040551.
19. Zarone F, Russo S, Sorrentino R. From porcelain-fused-to-metal to zirconia: clinical and experimental considerations. Dent Mater. 2011;27(1):83–96. PMID: 21094996.
20. Barão VAR, Gennari-Filho H, Goiato MC, dos Santos DM, Pesqueira AA. Factors to achieve aesthetics in all-ceramic restorations. J Craniofac Surg. 2010;21(6):2007–12. PMID: 21119487.
21. Capa N, Tuncel I, Tak O, Usumez A. The effect of luting cement and titanium base on the final color of zirconium oxide core material. J Prosthodont. 2017;26(2):136–40. PMID: 26426204.
22. Malkondu O, Tinastepe N, Kazazoglu E. Influence of type of cement on the color and translucency of monolithic zirconia. J Prosthet Dent. 2016;116(6):902–8. PMID: 27422235.
23. Tabatabaian F, Dalirani S, Namdari M. Effect of thickness of zirconia ceramic on its masking ability: an in vitro study. J Prosthodont. 2019;28(7):666–71. PMID: 28452411.
24. Carnaggio TV, Conrad R, Engelmeier RL, Gerngross P, Paravina R, Perezous L, et al. Retention of CAD/CAM all-ceramic crowns on prefabricated implant abutments: an in vitro comparative study of luting agents and abutment surface area. J Prosthodont. 2012;21(7):523–8. PMID: 22469271.
25. Ghinea R, Pérez MM, Herrera LJ, Rivas MJ, Yebra A, Paravina RD. Color difference thresholds in dental ceramics. J Dent. 2010;38(2):e57–e64. PMID: 20670670.
26. Nejatidanesh F, Savabi O, Jabbari E. Effect of surface treatment on the retention of implant-supported zirconia restorations over short abutments.

J Prosthet Dent. 2014;112(1):38–44. PMID: 24388717.

27. Carrabba M, Vichi A, Tozzi G, Louca C, Ferrari M. Cement opacity and color as influencing factors on the final shade of metal-free ceramic restorations. J Esthet Restor Dent. 2020;32(6):1–7. PMID: 32282998.
28. Tabatabaian F, Khodaei MH, Namdari M, Mahshid M. Effect of cement type on the color attributes of a zirconia ceramic. J Adv Prosthodont. 2016;8(6):449–56. PMID: 28018562.
29. Liu X, Fehmer V, Sailer I, Mojon P, Liu F, Pjetursson BE. Influence of different cements on the color outcomes of titanium-based lithium disilicate all-ceramic crowns and peri-implant soft tissue. Int J Prosthodont. 2020;33(1):63–73. PMID: 31860915.
30. Jankar AS, Kale Y, Pustake S, Bijjaragi S, Pustake B. Spectrophotometric study of the effect of luting agents on the resultant shade of ceramic veneers: an in vitro study. J Clin Diagn Res. 2015;9(9):ZC56–ZC60. PMID: 26501014.
31. Vichi A, Ferrari M, Davidson CL. Influence of ceramic and cement thickness on the masking of various types of opaque posts. J Prosthet Dent. 2000;83(4):412–7. PMID: 10756290.
32. Tsiliagkou A, Diamantopoulou S, Papazoglou E, Kakaboura A. Evaluation of reliability and validity of three dental colour-matching devices. Int J Esthet Dent. 2016;11(1):110–24. PMID: 26835527.
33. Mehl A, Bosch G, Fischer C, Ender A. In vivo tooth-color measurement with a new 3D intraoral scanning system in comparison to conventional digital and visual color determination methods. Int J Comput Dent. 2017;20(4):343–61. PMID: 29292410.
34. Khurana R, Tredwin C, Weisbloom M, Moles D. A clinical evaluation of the individual repeatability of three commercially available colour measuring devices. Br Dent J. 2007;203(11):675–80. PMID: 18084212.
35. Dozić A, Kleverlaan CJ, El-Zohairy A, Feilzer AJ, Khashayar G. Performance of five commercially available tooth color-measuring devices. J Prosthodont. 2007;16(2):93–100. PMID: 17362418.
36. Gómez-Polo C, Muñoz MP, Luengo MCL, Vicente P, Galindo P, Casado AMM. Comparison of the CIE-Lab and CIEDE2000 color difference formulas. J Prosthet Dent. 2016;115(1):65–70. PMID: 26412001.
37. Gurdal I, Atay A, Eichberger M, Cal E, Usumez A, Stawarczyk B. Color change of CAD-CAM materials and composite resin cements after thermocycling. J Prosthet Dent. 2018;120(4):546–52. PMID: 29703672.
38. Almeida JR, Schmitt GU, Kaizer MR, Boscato N, Moraes RR. Resin-based luting agents and color stability of bonded ceramic veneers. J Prosthet Dent. 2015;114(2):272–7. PMID: 25882974.
39. Sahebi S, Nabavizadeh M, Dolatkhah V, Jamshidi D. Short term effect of calcium hydroxide, mineral trioxide aggregate and calcium-enriched mixture cement on the strength of bovine root dentin. Iran Endod J. 2012;7(2):68–73. PMID: 23056122.
40. Mesbah M, Morsi S, Sabet E. Assessment of color stability of different resin cements having different modes of polymerization before and after aging. J Am Sci. 2016;12(4):45–51.
41. Kapoor R, Singh K, Kaur S, Arora A. Retention of implant-supported metal crowns cemented with different luting agents: a comparative in vitro study. J

Clin Diagn Res. 2016;10(4):ZC61–ZC64. PMID: 27190954.

42. Dantas TS, das Neves FD, do Prado CJ, Naves LZ, Muniz LA. Effects of abutment taper on the uniaxial retention force of cement-retained implant restorations. Rev Odontol Bras Central. 2013;22(2):110–4.
43. Meshramkar R, Nayak A, Kavlekar A, Nadiger RK, Lekha K. A study to evaluate the effect of taper on retention of straight and angled implant abutment. J Dent Implants. 2015;5(1):3–5.
44. Lüthy H, Loeffel O, Hämmerle CH. Effect of thermocycling on bond strength of luting cements to zirconia ceramic. Dent Mater. 2006;22(2):195–200. PMID: 16143382.
45. Wolfart M, Lehmann F, Wolfart S, Kern M. Durability of the resin bond strength to zirconia ceramic after using different surface conditioning methods. Dent Mater. 2007;23(1):45–50. PMID: 16427692.
46. Elsharkawy S, Shakal M, Elshahawy W. Effect of various surface treatments of implant abutment and metal cope fitting surface on their bond strength to provisional resin cement. Tanta Dent J. 2015;12(4):235–40.
47. Van Noort R. Introduction to Dental Materials. 2nd ed. Mosby; 2002.
48. Moraes RR, Correr-Sobrinho L, Sinhoreti MA, Puppin-Rontani RM, Ogliari F, Piva E. Light-activation of resin cement through ceramic: Relationship between irradiance intensity and bond strength to dentin. J Biomed Mater Res B Appl Biomater. 2008;85(1):160–5.
49. Archegas LR, Freire A, Vieira S, Caldas DB, Souza EM. Colour stability and opacity of resin cements and flowable composites for ceramic veneer luting after accelerated ageing. J Dent. 2011;39(10):804–10.
50. Lee YK, Powers JM. Color changes of resin composites in the reflectance and transmittance modes. Dent Mater. 2007;23(3):259–64.
51. Schulze KA, Marshall SJ, Gansky SA, Marshall GW. Color stability and hardness in dental composites after accelerated aging. Dent Mater. 2003;19(7):612–9.
52. International Organization for Standardization. ISO 7491: Dental materials – Determination of colour stability. Geneva: ISO; 2000.
53. Ferrari M, Patroni S, Balleri P. Measurement of enamel thickness in relation to reduction for etched laminate veneers. Int J Periodontics Restorative Dent. 1992;12(5):407–13.
54. Koishi Y, Tanoue N, Atsuta M, Matsumura H. Influence of visible-light exposure on colour stability of current dual-curable luting composites. J Oral Rehabil. 2002;29(4):387–93.
55. Buchalla W, Attin T, Hilgers RD, Hellwig E. The effect of water storage and light exposure on the color and translucency of a hybrid and a microfilled composite. J Prosthet Dent. 2002;87(3):264–70.
56. Lu H, Powers JM. Color stability of resin cements after accelerated aging. Am J Dent. 2004;17(5):354–8.
57. Tanoue N, Koishi Y, Atsuta M, Matsumura H. Properties of dual-curable luting composites polymerized with single and dual curing modes. J Oral Rehabil. 2003;30(10):1015–21.
58. Lee YK, Powers JM. Color and optical properties of resin-based composites for bleached teeth after polymerization and accelerated aging. Am J Dent. 2001;14(6):349–54.

59. Kilinc E, Antonson SA, Hardigan PC, Kesercioglu A. Resin cement color stability and its influence on the final shade of all-ceramics. J Dent. 2011;39 Suppl 1:e30–6.

60. Vichi A, Ferrari M, Davidson CL. Color and opacity variations in three different resin-based composite products after water aging. Dent Mater. 2004;20(6):530–4.

61. Chang J, Da Silva JD, Sakai M, Kristiansen J, Ishikawa-Nagai S. The optical effect of composite luting cement on all-ceramic crowns. J Dent. 2009;37(12):937–43.

62. O'Brien WJ. Dental Materials and Their Selection. 4th ed. Chicago: Quintessence Publishing Co Inc; 2002. p. 25–38.

63. Ferracane JL, Moser JB, Greener EH. Ultraviolet light-induced yellowing of dental restorative resins. J Prosthet Dent. 1985;54(4):483–7.

64. Sideridou I, Achilias DS, Spyroudi C, Karabela M. Water sorption characteristics of light-cured dental resins and composites based on bis-EMA/PCDMA. Biomaterials. 2004;25(2):367–76.

65. Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater. 2006;22(3):211–22.

66. Zarone F, Ferrari M, Mangano FG, Leone R, Sorrentino R. "Digitally oriented materials": focus on lithium disilicate ceramics. Int J Dent. 2016;2016:9840594.

67. Church TD, Jessup JP, Guillory VL, Vandewalle KS. Translucency and strength of high-translucency monolithic zirconium oxide materials. Gen Dent. 2017;65:48–52.

68. Yan J, Kaizer MR, Zhang Y. Load-bearing capacity of lithium disilicate and ultra-translucent zirconia. J Mech Behav Biomed Mater. 2018;88:170–5.

69. Putra A, Chung KH, Flinn BD, et al. Effect of hydrothermal treatment on light transmission of translucent zirconias. J Prosthet Dent. 2017;118:422–9.

70. Karaokutan I, Yilmaz-Savas T, Aykent F. Color stability of CAD/CAM lithium disilicate ceramics. J Prosthet Dent. 2016;115:71–7.

71. Silami FD, Tonani R, Alandia-Román CC, et al. Influence of different types of resin luting agents on color stability of ceramic laminate veneers subjected to accelerated artificial aging. Braz Dent J. 2016;27:95–100.

72. Mina NR, Baba NZ, Al-Harbi FA, et al. The influence of simulated aging on the color stability of composite resin cements. J Prosthet Dent. 2019;121:306–10.

73. Chu SJ, Trushkowsky RD, Paravina RD. Dental color matching instruments and systems. Review of clinical and research aspects. J Dent. 2010;38(Suppl 2):e2–16.

74. Haralur SB, Raqe S, Alqahtani N, et al. Effect of hydrothermal aging and beverages on color stability of lithium disilicate and zirconia based ceramics. Medicina. 2019;55:749.

75. Aljanobi G, Al-Sowygh ZH. The effect of thermocycling on the translucency and color stability of modified glass ceramic and multilayer zirconia materials. Cureus. 2020;12:e6968.

76. Rodrigues RB, Lima E, Roscoe MG, et al. Influence of resin cements on color stability of different ceramic systems. Braz Dent J. 2017;28:191–5.

77. Kurt M, Turhan BB. Effects of accelerated artificial aging on the translucency and color stability of monolithic ceramics with different surface treatments. J Prosthet Dent. 2019;122:e1–e8.
78. Volpato C, Cesar P, Bottino M. Influence of accelerated aging on the color stability of dental zirconia. J Esthet Restor Dent. 2016;28:304–12.
79. Nakamura K, Harada A, Ono M, et al. Effect of low-temperature degradation on the mechanical and microstructural properties of tooth-colored 3Y-TZP ceramics. J Mech Behav Biomed Mater. 2016;53:301–11.
80. Shah K, Holloway JA, Denry IL. Effect of coloring with various metal oxides on the microstructure, color and flexural strength of 3Y-TZP. J Biomed Mater Res B Appl Biomater. 2008;87:329–37.
81. Cotes C, Arata A, Melo RM, et al. Effects of aging procedures on the topographic surface, structural stability, and mechanical strength of a ZrO_2-based dental ceramic. Dent Mater. 2014;30:e396–404.
82. Chaiyabutr Y, Kois JC, Lebeau D, et al. Effect of abutment tooth color, cement color, and ceramic thickness on the resulting optical color of a fabricated inlays after accelerated artificial aging. J Prosthodont. 2016;25:472–7.
83. Vichi A, Louca C, Corciolani G, et al. Color related to ceramic and zirconia restorations: a review. Dent Mater. 2011;27:97–108.
84. Khashayar G, Bain PA, Salari S, et al. Perceptibility and acceptability thresholds for color differences in dentistry. J Dent. 2014;42:637–44.
85. Subaşı MG, Alp G, Johnston WM, et al. Effect of thickness on optical properties of monolithic CAD-CAM ceramics. J Dent. 2018;71:38–42.
86. Kim HK, Kim SH. Effect of hydrothermal aging on the optical properties of precolored dental monolithic zirconia ceramics. J Prosthet Dent. 2019;121:676–82.
87. Camposilvan E, Leone R, Gremillard L, et al. Aging resistance, mechanical properties and translucency of different Yttria-stabilized zirconia ceramics for monolithic dental crown applications. Dent Mater. 2018;34:879–90.
88. Harada K, Raigrodski AJ, Chung KH, et al. A comparative evaluation of the translucency of zirconias and lithium disilicate for monolithic restorations. J Prosthet Dent. 2016;116:257–63.
89. Kwon SJ, Lawson NC, McLaren EE, et al. Comparison of the mechanical properties of translucent zirconia and lithium disilicate. J Prosthet Dent. 2018;120:132–7.
90. Pecho OE, Ghinea R, Ionescu AM, et al. Color and translucency of zirconia ceramics, human dentine and bovine dentine. J Dent. 2012;40(Suppl 2):e34–40.
91. Kilinc E, Antonson SA, Hardigan PC, et al. Resin cement color stability and its influence on the final shade of all-ceramics. J Dent. 2011;39(Suppl 1):30–6.
92. Yildirim M, Fischer H, Marx R, et al. In vivo fracture resistance of implant-supported all-ceramic restorations. J Prosthet Dent. 2000;90:325–31.
93. Tan PLB, Dunne JT. An esthetic comparison of metal ceramic crown and cast metal abutment with an all-ceramic crown and zirconia abutment: a clinical report. J Prosthet Dent. 2004;91:215–8.
94. Brodbeck U. The ZiReal Post: a new ceramic implant abutment. J Esthet Restor Dent. 2003;15:10–23.
95. Vigolo P, Fonzi F, Majzoub Z, et al. An in vitro evaluation of ZiReal abutments with hexagonal connection: in original state and following abutment

preparation. Int J Oral Maxillofac Implants. 2005;20:108–14.

96. Andersson B, Taylor A, Lang B, et al. Alumina ceramic abutments used for single-tooth replacement: a prospective 1–3 year multicenter study. Int J Prosthodont. 2001;14:432–8.

97. Mustafa K, Oden A, Wenneberg A, et al. The influence of surface topography of ceramic abutments on the attachment and proliferation of human oral fibroblasts. Biomaterials. 2005;26:373–81.

98. Guazzato M, Quach L, Albakry M, et al. Influence of surface and heat treatments on the flexural strength of Y-TZP dental ceramic. J Dent. 2005;33:9–18.

99. Kosmac T, Oblak C, Jevnikar P, et al. Strength and reliability of surface treated Y-TZP dental ceramics. J Biomed Mater Res. 2000;53:304–13.

100. Kosmac T, Oblak C, Jevnikar P, et al. The effect of surface grinding and sandblasting on flexural strength and reliability of Y-TZP zirconia ceramic. Dent Mater J. 1999;15:426–33.

101. Luthardt RG, Holzhuter M, Sandkuhl O, et al. Reliability and properties of ground Y-TZP-zirconia ceramics. J Dent Res. 2002;81:487–91.

102. Zhang Y, Lawn B, Rekow ED, et al. Effect of sandblasting on the long-term performance of dental ceramics. J Biomed Mater Res B Appl Biomater. 2004;71:381–6.

103. Butz F, Heydecke G, Okutan M, et al. Survival rate, fracture strength and failure mode of ceramic implant abutments after chewing simulation. J Oral Rehabil. 2005;32:838–43.

104. Paphangkorakit J, Osborn JW. The effect of pressure on maximum incisal bite force in man. Arch Oral Biol. 1997;42:11–7.

105. Haraldson T, Carlsson GE, Ingervall B. Functional state, bite force and postural muscle activity in patients with osseointegrated oral implant bridges. Acta Odontol Scand. 1979;37:195–206.

106. Mitsias ME. Fatigue test analysis of two esthetic implant abutments [master's thesis]. New York: New York University; 2004.

107. Maeda Y, Satoh T, Sogo M. In vitro differences of stress concentrations for internal and external hex implant-abutment connections: a short communication. J Oral Rehabil. 2006;33:75–8.

108. Khraisat A, Stegaroiu R, Nomura S, et al. Fatigue resistance of two implant/abutment joint designs. J Prosthet Dent. 2002;88:604–10.

109. Tripodakis AP, Strub JR, Kappert HF, et al. Strength and mode of failure of single implant all-ceramic abutment restorations under static load. Int J Prosthodont. 1995;8:265–72.

110. Strub JR, Gerds T. Fracture strength and failure mode of five different single-tooth implant-abutment combinations. Int J Prosthodont. 2003;16:167–71.

111. Blue DS, Griggs JA, Woody RD, et al. Effects of bur abrasive particle size and abutment composition on preparation of ceramic implant abutments. J Prosthet Dent. 2003;90:247–54.

112. Zarb GJA. Mechanical fatigue of two dental luting agents in simulated function [master's thesis]. Chapel Hill (NC): University of North Carolina, School of Dentistry, Department of Prosthodontics; 1999

113. Papaspyridakos P, Chen C-J, Singh M, Weber H-P, Gallucci GO. Success criteria in implant dentistry: a systematic review. J Dent Res. 2012;91(3):242-8.

114. Glauser R, Sailer I, Wohlwend A, Studer S, Schibli M, Schärer P. Experimental zirconia

abutments for implant-supported single-tooth restorations in esthetically demanding regions: 4-year results of a prospective clinical study. Int J Prosthodont. 2004;17(3):285-90.

115. Gehrke P, Johannson D, Fischer C, Stawarczyk B, Beuer F. In vitro fatigue and fracture resistance of one- and two-piece CAD/CAM zirconia implant abutments. Int J Oral Maxillofac Implants. 2015;30(3):546-54.

116. Den Hartog L, Raghoebar GM, Slater JJH, Stellingsma K, Vissink A, Meijer HJA. Single-tooth implants with different neck designs: a randomized clinical trial evaluating the aesthetic outcome. Clin Implant Dent Relat Res. 2013;15(3):311-21.

117. Bidra AS, Rungruanganunt P. Clinical outcomes of implant abutments in the anterior region: a systematic review. J Esthet Restor Dent. 2013;25(3):159-76.

118. Linkevicius T, Vaitelis J. The effect of zirconia or titanium as abutment material on soft peri-implant tissues: a systematic review and meta-analysis. Clin Oral Implants Res. 2015;26(Suppl 11):139-47.

119. Zandparsa R, Albosefi A. An in vitro comparison of fracture load of zirconia custom abutments with internal connection and different angulations and thicknesses: part II. J Prosthodont. 2016;25(2):151-5.

120. Ellakwa A, Raj T, Deeb S, Ronaghi G, Martin FE, Klineberg I. Influence of implant abutment angulations on the fracture resistance of overlaying CAM-milled zirconia single crowns. Aust Dent J. 2011;56(2):132-40.

121. Mehl C, Zhang Q, Lehmann F, Kern M. Retention of zirconia on titanium in two-piece abutments with self-adhesive resin cements. J Prosthet Dent. 2018 Apr 5.

122. Fadanelli MA, Amaral FLB, Basting RT, Turssi CP, Sotto-Maior BS, França FMG. Effect of steam autoclaving on the tensile strength of resin cements used for bonding two-piece zirconia abutments. J Oral Implantol. 2017;43(2):87-93.

123. Kim JS, Raigrodski AJ, Flinn BD, Rubenstein JE, Chung K-H, Mancl LA. In vitro assessment of three types of zirconia implant abutments under static load. J Prosthet Dent. 2013;109(4):255-63.

124. Truninger TC, Stawarczyk B, Leutert CR, Sailer TR, Hämmerle CHF, Sailer I. Bending moments of zirconia and titanium abutments with internal and external implant-abutment connections after aging and chewing simulation. Clin Oral Implants Res. 2012;23(1):12-8.

125. Gehrke P, Alius J, Fischer C, Erdelt KJ, Beuer F. Retentive strength of two-piece CAD/CAM zirconia implant abutments. Clin Implant Dent Relat Res. 2014;16(6):920-5.

126. Alsahhaf A, Spies BC, Vach K, Kohal R-J. Fracture resistance of zirconia-based implant abutments after artificial long-term aging. J Mech Behav Biomed Mater. 2017;66:224-32.

127. Kajiwara N, Masaki C, Mukaibo T, Kondo Y, Nakamoto T, Hosokawa R. Soft tissue biological response to zirconia and metal implant abutments compared with natural tooth: microcirculation monitoring as a novel bioindicator. Implant Dent. 2015;24(1):37-41.

128. Martínez-Rus F, Prieto M, Salido MP, Madrigal C, Özcan M, Pradíes G. A clinical study assessing the influence of anodized titanium and zirconium dioxide abutments and peri-implant soft tissue thickness on the optical outcome of implant-supported lithium

disilicate single crowns. Int J Oral Maxillofac Implants. 2017;32(1):156-63.

129. Happe A, Schulte-Mattler V, Fickl S, Naumann M, Zöller JE, Rothamel D. Spectrophotometric assessment of peri-implant mucosa after restoration with zirconia abutments veneered with fluorescent ceramic: a controlled, retrospective clinical study. Clin Oral Implants Res. 2013;24(Suppl A100):28-33.

130. Thoma DS, Brandenberg F, Fehmer V, Knechtle N, Hämmerle CH, Sailer I. The esthetic effect of veneered zirconia abutments for single-tooth implant reconstructions: a randomized controlled clinical trial. Clin Implant Dent Relat Res. 2016;18(6):1210-7.

131. Zembic A, Bösch A, Jung RE, Hämmerle CHF, Sailer I. Five-year results of a randomized controlled clinical trial comparing zirconia and titanium abutments supporting single-implant crowns in canine and posterior regions. Clin Oral Implants Res. 2013;24(4):384-90.

132. Branzén M, Eliasson A, Arnrup K, Bazargani F. Implant-supported single crowns replacing congenitally missing maxillary lateral incisors: a 5-year follow-up. Clin Implant Dent Relat Res. 2015;17(6):1134-40.

133. Peixoto RF, De Aguiar CR, Jacob ES, Macedo AP, De Mattos Mda G, Antunes RP. Influence of temporary cements on the bond strength of self-adhesive cement to the metal coronal substrate. Braz Dent J. 2015;26(6):637-41.

134. Ajaj R, Al-Mutairi S, Ghandoura S. Effect of eugenol on bond strength of adhesive resin: a systematic review. Oral Health Dent Manag. 2014;13(4):950-8.

135. Pinto KT, Stanislawczuk R, Loguercio AD, Helena R, Grande M, Bauer J. Effect of exposure time of zinc oxide eugenol restoration on microtensile bond strength of adhesives to dentin. Rev Port Estomatol Med Dent Cir Maxilofac. 2014;55(2):83-8.

136. Nasreen F, Guptha AB, Srinivasan R, Chandrappa MM, Bhandary S, Junjanna P. An in vitro evaluation of effect of eugenol exposure time on the shear bond strength of two-step and one-step self-etching adhesives to dentin. J Conserv Dent. 2014;17(3):280-4.

137. Watanabe EK, Yamashita A, Yatani H, Ishikawa K, Suzuki K. Improvement in the tensile bond strength between resin cement and dentin surfaces after temporary cement application. Int J Prosthodont. 1998;11(3):203-11.

138. Al-Wazzan KA, Al-Harbi AA, Hammad IA. The effect of eugenol-containing temporary cement on the bond strength of two resin composite core materials to dentin. J Prosthodont. 1997;6(1):37-42.

139. Sabouhi M, Nosouhian S, Davoudi A, Nourbakhshian F, Badrian H, Nabe FN. The effect of eugenol-free temporary cement's remnants on retention of full metal crowns: Comparative study. J Contemp Dent Pract. 2013;14(3):473-7.

140. Fonseca RB, Martins LR, Quagliatto PS, Soares CJ. Influence of provisional cements on ultimate bond strength of indirect composite restorations to dentin. J Adhes Dent. 2005;7(3):225-30.

141. André CB, Aguiar TR, Ayres AP, Ambrosano GM, Giannini M. Bond strength of self-adhesive resin cements to dry and moist dentin. Braz Oral Res. 2013;27(5):389-95.

142. Saraç D, Bulucu B, Saraç YS, Kulunk S. The effect of dentin-cleaning agents on resin cement bond strength to dentin. J Am Dent Assoc. 2008;139(6):751-8.

143. Peutzfeldt A, Asmussen E. Influence of eugenol-containing temporary cement on bonding of self-etching adhesives to dentin. J Adhes Dent. 2006;8(1):31-4.

144. Leirskar J, Nordbø H. The effect of zinc oxide-eugenol on the shear bond strength of a commonly used bonding system. Endod Dent Traumatol. 2000;16(6):265-8.

145. Carvalho EM, Carvalho CN, Loguercio AD, Lima DM, Bauer J. Effect of temporary cements on the microtensile bond strength of self-etching and self-adhesive resin cement. Acta Odontol Scand. 2014;72(8):762-9.

146. Bagis B, Bagis YH, Hasanreisoglu U. Bonding effectiveness of a self-adhesive resin-based luting cement to dentin after provisional cement contamination. J Adhes Dent. 2011;13(6):543-50.

147. Schwartzer E, Collares F, Ogliari F, Leitune V, Samuel S. Influence of zinc oxide-eugenol temporary cement on bond strength of an all-in-one adhesive system to bovine dentin. Braz Oral Res. 2007; 21(2):142-7.

148. Altmann AS, Leitune VC, Collares FM. Influence of eugenol-based sealers on push-out bond strength of fiber post luted with resin cement: Systematic review and meta-analysis. J Endod. 2015;41(9):1418-23.