Comparison of Phosphate Cement and Resin Composite Cement Used for Cementation of Zirconia Crowns in Terms of Bond Strength, Clinical Longevity, and Failure Rate: A Scientific Literature Review

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SUMMARY

Relevance of the problem and aim of the work

The increasing use of zirconia crowns in restorative dentistry has raised important questions regarding the optimal choice of luting cement. Due to the unique properties of zirconia, particularly its resistance to conventional bonding techniques, the selection of an appropriate cement plays a critical role in the success of restorations. The aim of this study was to compare phosphate cement and resin composite cement used for the cementation of zirconia crowns in terms of bond strength, clinical longevity, and failure rate.

Material and methods

A scientific literature review was conducted using electronic databases, primarily PubMed. The search strategy combined MeSH terms and free-text keywords related to zirconia crowns, resin cement, phosphate cement, and clinical outcomes. Studies were selected based on predefined inclusion and exclusion criteria, and both in vitro and clinical studies were included in the analysis.

Results

The results showed that resin-based cements generally demonstrate higher bond strength to zirconia and maintain acceptable performance after aging procedures. Clinical studies also reported satisfactory longevity and low failure rates of zirconia crowns cemented with both resin and phosphate cements. However, limited data were available for phosphate cement, and direct comparisons between cement types were scarce.

Conclusions

Resin-based cements demonstrated higher bond strength compared to phosphate cement. Zirconia crowns cemented with both resin and phosphate cements showed satisfactory clinical longevity.

Failure rates were generally low regardless of the cementation method, although limited data were available for phosphate cement.

Keywords: zirconia crowns, resin cement, zinc phosphate cement, bond strength, survival rate, debonding

SANTRAUKA

Problemos aktualumas ir darbo tikslas

Didėjantis cirkonio oksido vainikėlių naudojimas restauracinėje odontologijoje kelia svarbius klausimus dėl tinkamiausio cemento pasirinkimo jų fiksavimui. Dėl unikalių cirkonio oksido savybių, ypač atsparumo įprastoms adhezijos technikoms, tinkamo cemento parinkimas yra itin svarbus restauracijų sėkmei. Šio darbo tikslas buvo palyginti fosfatinį cementą ir dervinius kompozitinius cementus, naudojamus cirkonio oksido vainikėlių cementavimui, įvertinant sukibimostiprumą, klinikinį ilgaamžiškumą ir nesėkmių dažnį.

Medžaga ir metodai

Buvo atlikta mokslinės literatūros apžvalga, naudojant elektronines duomenų bazes, daugiausia PubMed. Paieškos strategija apėmė MeSH terminus ir laisvo teksto raktinius žodžius, susijusius su cirkonio oksido vainikėliais, derviniais ir fosfatiniais cementais bei klinikiniais rezultatais. Tyrimai buvo atrinkti pagal iš anksto nustatytus įtraukimo ir atmetimo kriterijus, o analizėje buvo įtraukti tiek in vitro, tiek klinikiniai tyrimai.

Rezultatai

Rezultatai parodė, kad derviniai cementai paprastai pasižymi didesniu sukibimo stiprumu su cirkonio oksidu ir išlaiko priimtiną efektyvumą po imituojamo sendinimo procedūrų. Klinikiniai tyrimai taip pat parodė, kadcirkonio oksido vainikėliai, cementuoti tiek derviniais, tiek fosfatiniais cementais, pasižymi pakankamu ilgaamžiškumu ir mažu nesėkmių dažniu. Tačiau duomenų apie fosfatinį cementą buvo nedaug, o tiesioginiaiskirtingų cementų palyginimai buvo riboti.

Išvados

Derviniai cementai pasižymi didesniu sukibimo stiprumu su cirkonio oksidu, lyginant su fosfatiniu cementu. Cirkonio oksido vainikėliai, cementuoti tiek derviniais, tiek fosfatiniais cementais, pasižymi pakankamuklinikiniu ilgaamžiškumu. Nesėkmių dažnis paprastai yra mažas nepriklausomai nuo cemento tipo, tačiau duomenų apie fosfatinį cementą yra ribotai.

Raktažodžiai: cirkonio oksido vainikėliai, dervinis cementas, cinko fosfatinis cementas, sukibimo stiprumas, ilgaamžiškumas, atsicementavimas

1. INTRODUCTION

1.1 Background

In recent decades, zirconia has become one of the most used materials in restorative dentistry due to its mechanical and biological properties. Yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) is characterized by high flexural strength, fracture resistance, and biocompatibility, making it suitable for use in fixed dental prothesis, in particular crowns [1,2]. Moreover, zirconia exhibits low plaque accumulation and good tissue response [2].

The increasing demand for aesthetic and durable dental restorations has also contributed to the growing popularity of zirconia crowns. Compared to the traditional metal ceramic restorations, zirconia-based crowns offer better aesthetics while maintaining high strength, allowing their use in both anterior and posterior regions [3]. As a result, zirconia has become the material of choice in modern prosthodontics.

1.2 Properties of Zirconia

Zirconia has unique mechanical properties that distinguish it from other ceramic materials used in dentistry. One of its most important characteristics is transformation toughening, a mechanism that allows zirconia to resist crack propagation. When stress is applied, the crystal structure undergoes a phase transformation from tetragonal to monoclinic, resulting in a localized volume expansion that helps to prevent further crack growth [2]. This property contributes significantly to the high fracture resistance of zirconia restorations.

Moreover, zirconia demonstrates favorable biological properties, including excellent biocompatibility and low bacterial adhesion. These characteristics are particularly important in maintaining periodontal health and minimizing inflammatory responses in the surrounding tissues [1]. Furthermore, zirconia shows resistance to corrosion and chemical degradation in the oral environment, which supports its long-term clinical stability [2].

However, despite these advantages, zirconia also presents certain limitations. Its high crystalline content and lack of a glass phase reduce its ability to be etched using conventional hydrofluoric acid

techniques, which complicates adhesive bonding procedures [4]. This limitation has led to the development of alternative bonding strategies and the increased use of resin-based cements in clinical practice.

1.3 Challenges of Zirconia Bonding

Despite its favorable mechanical properties, zirconia presents specific challenges related to bonding and cementation. Unlike silica-based ceramics, zirconia lacks a glass phase and is resistant to conventional acid etching techniques [5,4]. This characteristic limits the effectiveness of traditional adhesive protocols and complicates the establishment of a reliable bond between the restoration and the tooth structure.

Because of this, the retention of zirconia crowns often depends on a combination of mechanical factors and the properties of the luting cement. Surface treatments and the use of specialized primers have been proposed to enhance bonding; however, these approaches add complexity to the clinical procedure and may influence the final outcome [6] As a result, the selection of an appropriate cement becomes important for successful zirconia crown cementation.

1.4 Types of Zirconia

Different types of zirconia materials have been developed in recent years to improve optical and mechanical properties. The most commonly used form in dentistry is 3 mol% yttria-stabilized tetragonal zirconia polycrystal (3Y-TZP), which offers high strength but relatively limited translucency. To address aesthetic demands, newer generations such as 4Y-TZP and 5Y-TZP have been introduced, providing increased translucency at the expense of reduced mechanical strength [3,7].

These variations in composition may influence not only the optical properties of zirconia restorations but also their bonding behavior and clinical performance. For example, increased translucency is often associated with changes in grain size and phase composition, which could potentially affect surface reactivity and adhesion to luting cements.

1.5 Luting Cements in Zirconia Crown Cementation

Various luting cements are available and used for the cementation of zirconia crowns such as, conventional zinc phosphate cements, glass ionomer cements and resin-based cements [8]. Each of these material differ in terms of bonding mechanism, mechanical properties and clinical handling.

Zinc phosphate cement has been used in dentistry for many years and is considered a reliable material with predictable clinical results. Its retention is primarily based on mechanical interlocking rather than chemical bonding [8]. While it offers advantages such as ease of use and long-term clinical experience, it does not provide adhesive bonding to zirconia surfaces.

In contrast, resin-based cements have gained increasing attention due to their ability to establish micromechanical and chemical adhesion to both tooth structure and restorative materials [5,9]. The presence of functional monomers, such as MDP, allows resin cements to interact with zirconia surfaces, potentially improving retention and stability [4]. However, resin cements also have certain limitations, including technique sensitivity and the need for proper isolation during cementation.

1.6 Comparison of Cement Types

The choice between conventional and resin-based cements is influenced by several clinical and material-related factors. Conventional cements, such as zinc phosphate, rely primarily on mechanical retention and have a long history of successful clinical use [8]. They are less technique-sensitive and do not require complex bonding protocols, which may simplify clinical procedures [1].

In contrast, resin cements offer the advantage of adhesive bonding, which may enhance retention, particularly in situations where preparation geometry is compromised [9]. Their ability to chemically interact with zirconia surfaces through functional monomers provides an additional mechanism of retention that is not present in conventional cements [4].

Despite these advantages, resin cements are more sensitive to clinical conditions, including moisture control and surface preparation. Improper handling or contamination may negatively affect

their bonding performance. Consequently, the selection of cement should be based on a balance between ease of use, clinical conditions, and the desired level of retention.

1.7 Clinical Relevance

The long-term success of zirconia crowns depends on several factors, including preparation design, occlusal forces, marginal fit, and the choice of cement. Poor cementation may lead to complications such as debonding, marginal leakage, or restoration failure [6,10]. Although resin cements are widely studied and commonly used in clinical practice, conventional cements such as zinc phosphate are still utilized in certain clinical situations. However, there is limited consensus regarding the superiority of one cement type over another, particularly in relation to zirconia restorations [11,12]. This lack of clear evidence highlights the need for a comprehensive evaluation of the available literature.

1.8 Aim of the Study

The aim of this scientific literature review is to compare phosphate cement and resin composite cement used for the cementation of zirconia crowns in terms of bond strength, clinical longevity, and failure rate.

1.9 Objectives

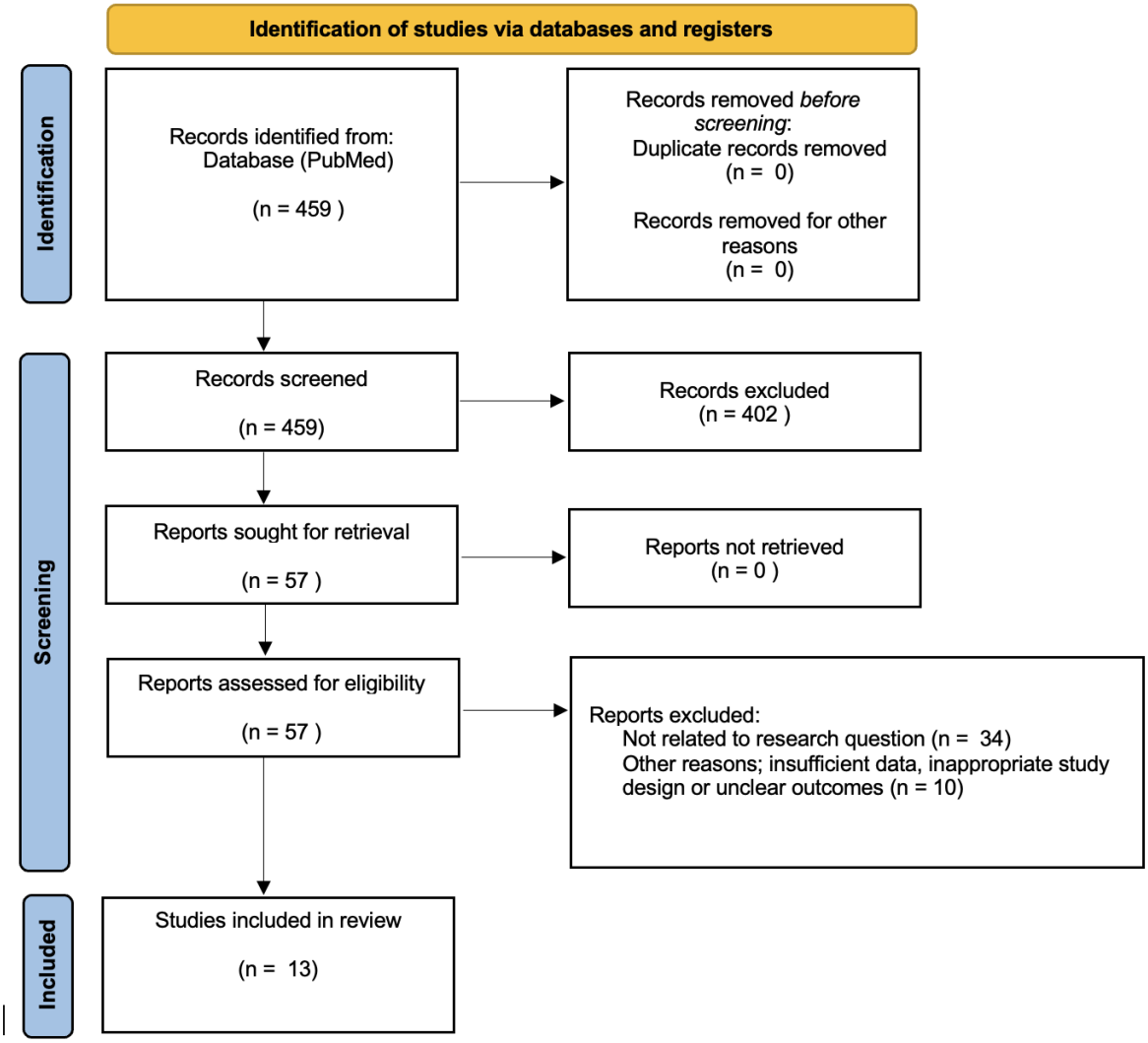
The objectives of this study are:

- To evaluate and compare the bond strength of zirconia crowns cemented with resin and phosphate cements as reported in in vitro studies.
- To assess the clinical longevity of zirconia crowns cemented with phosphate and resin composite cements based on clinical studies.
- To analyze the failure rate associated with different cementation methods

2. CRITERA FOR ARTICLES SELECTION. SEARCH METHODS AND STRATEGY

2.1. Protocol

This literature review was made using search strategy according to the general principles of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [fig 1]. The following approach was used to identify and select scientific publications about cementation of zirconia crowns using phosphate cement and resin composite cement.



2.2. Study Design

This study was conducted as a scientific literature review aimed at evaluating and comparing the performance of phosphate cement and resin-based cements used for the cementation of zirconia crowns. The review focused on three main outcomes: bond strength, clinical longevity, and failure rate.

The research process included a structured search of the available literature, followed by screening and selection of relevant studies based on predefined criteria. The methodology was designed to ensure a systematic and transparent approach to data collection and analysis.

2.3. Research Question and PICOS Framework

The research question of this review was structured using the PICOS framework in order to clearly define the key components of the study.

- **Population (P):** Teeth restored with zirconia crowns
- **Intervention (I):** Cementation using resin-based cements
- **Comparison (C):** Cementation using phosphate (zinc phosphate) cement
- **Outcomes (O):** Bond strength, clinical longevity, and failure rate
- **Study design (S):** In vitro studies and clinical studies

2.4. Search strategy

A literature search was conducted using electronic databases to identify relevant studies published within the last ten years. The primary database used for this review was PubMed.

The search strategy was performed using a combination of keywords and applicable, Medical Subject Headings (MeSH). The used terms were:

[zirconia crown OR zirconia restoration OR yttria-stabilized zirconia] AND

[phosphate cement OR zinc phosphate cement OR resin cement OR resin composite cement OR self-adhesive resin cement] AND

[bond strength OR clinical survival OR failure rate OR debonding]

The final search strategy was structured to identify studies evaluating zirconia crown cementation and the performance of different luting agents. The search was performed [**2026-02-14**] with the final search string being: (zirconia crown OR zirconia restoration OR yttria-stabilized zirconia) AND (phosphate cement OR zinc phosphate cement OR resin cement OR resin composite cement OR self-adhesive resin cement) AND (bond strength OR clinical survival OR failure rate OR debonding).

2.5. Eligibility Criteria

Studies were selected based on predefined inclusion and exclusion criteria to ensure consistency and relevance to the research aim.

Inclusion Criteria

- Studies evaluating zirconia crowns or zirconia-based restorations
- Studies investigating resin-based or phosphate cements
- Studies reporting outcomes related to bond strength, retention, clinical survival, or failure rate
- In vitro studies and clinical studies
- Articles published in English

Exclusion Criteria

- Review articles, systematic reviews, and meta-analyses
- Studies focusing primarily on surface treatment, primers, or repair methods
- Studies involving materials other than zirconia (e.g., lithium disilicate)
- Studies on fixed dental prostheses (bridges) rather than single crowns
- Case reports and studies with insufficient data

2.6. Study Selection Process

The study selection process was conducted in several stages. Initially, all identified records were screened based on their titles to exclude clearly irrelevant studies. Following this, abstracts of the remaining articles were reviewed to determine their relevance according to the inclusion and exclusion criteria.

Full-text articles were then assessed for eligibility. During this stage, studies that did not meet the predefined criteria were excluded. Reasons for exclusion included lack of relevance to zirconia crown cementation, focus on unrelated variables such as surface treatment, or absence of usable outcome data.

The study selection process resulted in a final set of studies that were included in the review. The process is summarized in the PRISMA flow diagram [fig 1].

2.7. Data Extraction and Analysis

Relevant data were extracted from the included studies, including information on study design, type of cement used, testing methods, and reported outcomes. For in vitro studies, bond strength values and retention measurements were analyzed. For clinical studies, outcomes such as survival rates and failure rates were considered.

Due to the heterogeneity of the included studies, including differences in methodology and outcome measures, a quantitative synthesis or meta-analysis was not performed. Instead, a qualitative analysis of the findings was conducted, focusing on identifying patterns and trends across the studies.

The results were then organized into thematic categories, including bond strength, retention and durability, and clinical performance, in order to facilitate comparison between different cement types.

2.8. Risk of bias assessment

The methodological quality of the included clinical studies was assessed using the Joanna Briggs Institute (JBI) critical appraisal tools appropriate to each study design. JBI critical appraisal tools are intended to support assessment of the trustworthiness, relevance, and results of published studies. The tools available on the official JBI critical appraisal tools page include specific instruments for randomized controlled trials, cohort studies, case series, quasi-experimental studies, and analytical cross-sectional studies.

For the present review, the JBI checklist for randomized controlled trials was applied to randomized clinical trials, while the JBI tools for cohort studies or case series were applied to observational clinical studies according to the final design classification reported in each article. The appraisal was focused on methodological features that could influence the credibility of findings related to clinical longevity and failure rate.

Because the majority of included laboratory studies were in vitro investigations of bond strength, these studies were not assessed with a formal JBI tool, as no dedicated official JBI critical appraisal checklist for in vitro dental material studies was identified on the JBI critical appraisal tools page. Instead, these studies were interpreted descriptively, with attention to methodological variability such as specimen preparation, cementation protocol, aging conditions, and bond strength testing methods.

2.8.1. Classification of included studies and selected JBI critical appraisal tools

Table 1: Classification of studies using JBI

Study	Study design	JBI tool used	Overall appraisal
Aziz and El-Mowafy, 2023	Retrospective clinical study	JBI Cohort	Low / Moderate / High concern
Srinivasan et al., 2023	Randomized clinical trial	JBI RCT	Low / Moderate / High concern
Torres et al., 2021	Randomized clinical trial	JBI RCT	Low / Moderate / High concern

2.8.2. Table 2, JBI checklist for Cohort

For improved table readability, the items of the JBI checklist for cohort study were coded as Q1-Q11 in the risk of bias table. The meaning of each coded item is presented below.

- **Q1** Were the two groups similar and recruited from the same population?
- **Q2** Were exposures measured similarly to assign people to exposed and unexposed groups?
- **Q3** Was the exposure measured in a valid and reliable way?
- **Q4** Were confounding factors identified?
- **Q5** Were strategies to deal with confounding factors stated?
- **Q6** Were participants free of the outcome at the start of the study, or at the moment of exposure?
- **Q7** Were the outcomes measured in a valid and reliable way?
- **Q8** Was the follow-up time reported and long enough for outcomes to occur?
- **Q9** Was follow-up complete, and if not, were reasons for loss to follow-up described and explored?
- **Q10** Were strategies to address incomplete follow-up utilized?
- **Q11** Was appropriate statistical analysis used?

Table 2: JBI checklist for cohort (Y=Yes, N=No)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Overall risk of bias
Aziz & El-Mowafy (2023)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Low to moderate

2.8.3. Table 3, JBI checklist for Randomized controlled trial

For improved table readability, the items of the JBI checklist for randomized control trial were coded as Q1-Q13 in the risk of bias table. The meaning of each coded item is presented below.

- **Q1** Was true randomization used for assignment of participants to treatment groups?
- **Q2** Was allocation to treatment groups concealed?
- **Q3** Were treatment groups similar at baseline?
- **Q4** Were participants blind to treatment assignment?
- **Q5** Were those delivering treatment blind to treatment assignment?
- **Q6** Were outcome assessors blind to treatment assignment?
- **Q7** Were treatment groups treated identically other than the intervention of interest?
- **Q8** Was follow-up complete and, if not, were differences between groups adequately described and analyzed?
- **Q9** Were participants analyzed in the groups to which they were randomized?
- **Q10** Were outcomes measured in the same way for treatment groups?
- **Q11** Were outcomes measured in a reliable way?
- **Q12** Was appropriate statistical analysis used?
- **Q13** Was the trial design appropriate, and were any deviations from standard RCT design accounted for in the conduct and analysis?

Table 3: JBI checklist for randomized controlled trial (Y=Yes, UN= Unclear, N=No)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Risk of bias
Srinivasan et al. (2023)	Y	UN	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Moderate
Torres et al. (2021)	Y	Y	Y	Y	N	Y	Y	UN	Y	Y	Y	Y	N	Moderate

3. RESULTS

3.1. Study Selection

Post electronic database search a total of 459 records were identified. After title screening 57 reports were chosen for further analysis. Assessment of these 57 reports showed that there was a need to exclude reports due to them not meeting the inclusion criteria, such as review articles, studies focusing primarily on surface treatment methods, or those researching other materials than zirconia crowns. Ultimately a total of 13 studies were included in this literature review. Detailed selection of studies is illustrated in the PRISMA flow diagram. [fig 1]

3.2. Study Characteristics

The studies chosen to be included were comprised of both in vitro experimental studies and clinical investigations. However the majority of the selected studies were laboratory based studies evaluating bond strength and retention of zirconia restorations using different resin cements. These studies usually used shear bond strength or tensile bond strength testing methods under controlled conditions.

Moreover, only a limited number of clinical studies were identified, including retrospective and randomized clinical trials. These studies evaluated clinical outcomes such as crown survival, retention and failure rates over time.

Most of the 13 included studies focused on resin-based cements, specifically self-adhesive resin cements. However very few studies investigated conventional luting agents like glass ionomer or zinc phosphate cements. A direct comparison between different cement types were relatively limited.

3.3. Bond Strength of Resin Cements to Zirconia

Multiple in vitro studies evaluated the bond strength between zirconia surfaces and resin-based cements. These studies consistently showed that resin cements are capable of achieving measurable bond strength to zirconia substrates under various conditions.

Liu et al. [13] investigated the bond strength of self-adhesive resin cements to high translucency zirconia crowns and reported that these materials exhibited reliable adhesion to both zirconia and dentin surfaces. Likewise Kim et al. [14] investigated tensile bond strength and found that self-adhesive resin cements demonstrated stable bonding to zirconia following surface pretreatment.

More studies, including those by Samran et al. [15] and Go et al. [16], further supported these findings by demonstrating that resin cements maintain bond strength after aging procedures, indicating a degree of durability under simulated oral conditions. In comparison, in vitro studies also showed differences between resin cement formulations. Serichetaphongse et al. [17] showed that different resin cements exhibited varying bond strength values when applied to zirconia surfaces concluding that material composition plays a role in bonding performance.

The findings from laboratory studies show that resin cement can achieve consistent and durable adhesion to zirconia, however results may vary depending on cement type and experimental conditions.

3.4. Retention and Durability of Resin Cements

Moreover, several studies evaluated the retention and durability of resin cements when they are used for cementation of zirconia crowns. Retention and durability are very important as they provide a view into the long-term performance of restorations under simulated oral conditions.

Pilo et al. [18] investigated the strength of retention of zirconia crowns cemented with self-adhesive resin cements and wrote that these materials provided adequate retention values suggesting their suitability for clinical use. Likewise, Levartovsky et al. [19] evaluated the retentive strength of zirconia crowns before and after an aging period of six months and demonstrated that resin cements maintained their bonding performance over time, however some reduction in retention was observed after aging.

Durability was also further investigated in studies using thermocycling and other artificial aging protocols. Samran et al. [15] reported that self-adhesive resin cements retained acceptable bond strength after aging procedures, indicating resistance to degradation in simulated oral environments. These findings show that resin cements can maintain functional adhesion over time but environmental factors may have an effect on their long-term stability.

In summary the included studies indicate that resin-based cements provide reliable retention and durability when used with zirconia restorations, particularly under controlled laboratory conditions.

3.5. Clinical Performance and Survival of Zirconia Crowns

A limited number of clinical studies were found that evaluated the performance of zirconia crowns cemented with different luting agents.

Aziz and El-Mowafy [20] made a retrospective clinical study to investigate and evaluate zirconia crowns cemented with two different resin cements. The results showed positive clinical performance with high survival rates and low complications observed during the follow-up period. The author suggested resin cements can provide predictable outcomes in clinical settings.

Srinivasan et al. [21] performed a randomized clinical trial in which they compared three different luting cements used for zirconia crowns in primary molars over a 36-month period. The authors reported good clinical performance across all cement types with no significant differences in failure rates observed among the groups. These findings show that multiple cement types may be clinically acceptable for zirconia crown cementation.

Torres et al. [22] compared the clinical performance of zirconia crowns cemented with glass ionomer and self-adhesive resin cements, the study showed comparable outcomes between the two cement types, with both showing good survival rates over the observation period. The available clinical evidence suggests that zirconia crowns show high survival rates regardless of the cement type used, however the number of comparative studies are limited. Resin cements were the most frequently investigated materials and demonstrated favorable clinical outcomes.

4. DISCUSSION

4.1. General Overview of Findings

This literature review aimed to compare phosphate cement and resin-based cements used for the cementation of zirconia crowns whilst focusing on bond strength, clinical longevity, and failure rate. Based on the selected studies, it becomes clear that most of the available articles are focused around resin cements while much fewer studies investigate conventional cements such as zinc phosphate especially within the last 10 years.

Most in vitro studies included in this review showed that resin cements can achieve reliable bond strength to zirconia surfaces. These findings were consistent across different artilces, although variations in methodology, like surface treatment protocols and aging procedures influenced the reported values. Despite these differences, the overall results indicates that resin-based cements has stable adhesion to zirconia.

Clinical studies also showed favorable outcomes for zirconia crowns cemented with resin-based materials. High survival rates and low complication rates were reported, supporting the further use of these cements in clinical practice.

4.2. Resin Cements and Bond Strength

One of the most consistent and common findings across the reviewed studies is resin cements ability to establish a bond with zirconia, which is otherwise a non-etchable material [18,19]. This was particularly intresting, as zirconia lacks the glass phase that is present in other ceramic materials, making traditional bonding procedures less effective [5,4].

The in vitro studies showed that self-adhesive and dual-cured resin cements achieve better bond strength values when used with zirconia [13-17,23]. Several studies showed that these bonds can be maintained even after artificial aging procedures demonstrating a certain level of durability under simulated oral conditions [15,19].

It should be noted that the bond strength values varied between studies. This could be explained by differences in conditions, including surface preparation methods, type of resin cement, and testing protocols [17,24,25]. While resin cements demonstrate good results, direct comparison between studies is currently still challenging [4,6].

4.3. Retention and Long-Term Performance

In addition to bond strength, retention and long-term performance are all very important factors for the success of zirconia crowns. The reviewed studies explain that resin cements can provide sufficient retention, even after aging procedures such as thermocycling [18,19]. However some degree of reduction in bond strength and retention was observed after aging. This demonstrates the impact of oral conditions such as moisture, temperature fluctuations, and mechanical loading [15,19]. These findings demostrates the importance of considering long-term durability rather than relying only on initial bond strength values [6].

Clinical studies included in this review support the use of resin cements, as they show good survival rates over time [20-22]. The number of long-term clinical studies remains limited, which restricts the ability to draw strong conclusions regarding long-term performance [11].

4.4. Comparison with Conventional Cements

One of the objectives of this review was to compare resin cements with conventional luting agents, particularly zinc phosphate cement. One of the most notable findings was the limited availability of studies directly comparing these materials in the context of zirconia crowns. This may be explained by the shift in modern dentistry toward adhesive techniques. Over the past decades, resin-based cements have gained attention due to their ability to provide micromechanical and chemical

bonding to restorative materials, including zirconia. As a result, much of the research has focused on improving bonding protocols and optimizing resin cement performance. Conventional cements like zinc phosphate have been used for many years and are well-established materials with predictable clinical behavior. Because of this, they have attracted less research interest in recent years. Moreover, zirconia has specific bonding challenges due to its chemical stability this has further increased the need of research toward adhesive solutions rather than traditional luting approaches.

This imbalance in the literature does not indicate that phosphate cements are inferior, but rather reflects current research trends and priorities within the restorative dentistry field. Only a small number of studies included comparisons between different types of cements [21,22,25], and even fewer specifically evaluated phosphate cement. Despite this limitation, clinical studies that included alternative cement types, such as glass ionomer cements, showed that good clinical outcomes can be achieved with different luting agents [22]. This could indicate that other factors than cement type, such as preparation design and crown fit, also play a significant role in clinical success [10].

4.5. Clinical Implications

From a clinical standpoint, the findings of this review propose that resin-based cements are a reliable alternative for the cementation of zirconia crowns specifically in situations where more retention and adhesion is needed. The in vitro studies included in this review repeatably showed that resin cements can establish a bond to zirconia surfaces [13–17,23]. Clinical investigations also reported high survival rates and low complication rates when these materials were used [20,21]. Because resin cement excel at providing both micromechanical and chemical adhesion it becomes very useful in cases where there is limited mechanical retention such as short crown preparations [9]. In those cases using conventional cements may not be good enough to ensure long-term stability that adhesive cements use. Moreover it is important to understand that the performance of zirconia crowns is not only because of the type of cement used, there are other factors that play a significant role in treatment outcomes such as preparation design, marginal fit, occlusal load and operator technique [21,22,10]. Conventional zinc phosphate cements have been used successfully for many years and the limited number of studies evaluating their performance with zirconia crowns makes it difficult to draw an exact conclusion about their effectiveness in comparison to resin

cements. However clinical evidence shows favorable outcomes being achieved with non-adhesive cements, especially in cases where there is sufficient mechanical retention [22,8].

4.6. Limitations of the Review

Several limitations should be considered when interpreting the findings of this literature review.

Firstly, the majority of included studies were in vitro investigations, which may not fully replicate clinical conditions [6]. Although laboratory studies provide valuable insights, their results should be interpreted with caution when applied to clinical practice.

Secondly, there was considerable heterogeneity among the included studies in terms of methodology, materials, and testing protocols. This variability makes direct comparison between studies difficult and limits the ability to draw definitive conclusions.

Thirdly, was the access to a relatively small number of clinical studies. While the included clinical studies provided useful information on survival and failure rates the overall evidence is still limited [11,12].

A significant imbalance was found in the literature, with the majority of studies focusing resin-based cement and very few studies evaluated zinc phosphate cements. Therefore it limits the ability to draw strong conclusions about the comparative performance of these different cements.

Finally, the inclusion of studies with varying desgins may have influenced the overall findings of this review. Conclusions should therefore be interpreted within the context of these limitations.

4.7. Theoretical Comparison of Cement Types

Although comparative studies between resin and phosphate cements for zirconia crown cementation are limited, the differences can be understood based on their bonding mechanisms and properties.

Resin-based cements are designed to provide both micromechanical and chemical adhesion. The presence of functional monomers, like MDP, allows for interaction with zirconia surface, potentially

improving bond strength and retention [13-17]. This adhesive capability is particularlyuseful in situations where mechanical retention is compromised, such as short clinical crowns or minimally invasive preparations.

In contrast, conventional cements like zinc phosphate, soley relies on mechanical interlocking between the cement and the tooth structure. They do not form a chemical bond with zirconia, which may limit their effectiveness in cases where retention is insufficient [22]. However, their long history of clinical use and predictability make them a reliable option in well suited situations.

It should also be mentioned that the success of zirconia crowns does not soley depend on the type of cement used. Factors such as preparation geometry, occlusal forces, and marginal adaptation play an important role in clinical outcomes. While resin cements may offer advantages in terms of bonding, conventional cements may still be suitable in specific clinical situations.

Overall, the theoretical comparison suggests that resin cements provide additional retention through adhesion, in contrast to phosphate cements that depend on mechanical retention, which may influence their clinical indications.

4.8. Future Perspectives

The findings of this review demonstrates several gaps in the current literature, especially regarding the limited number of studies evaluating phosphate cement in zirconia crown cementation. Future research should aim to address this imbalance by conducting well-designed comparative studies that directly evaluate the performance of different cement types under both laboratory and clinical settings.

More long-term clinical studies are needed to assess the survival and failure rates of zirconia crowns over extended follow-up periods. While in vitro studies provide valuable views into bonding mechanisms, they cannot fully replicate the complexity of the oral environment. Therefore clinical trials remain essential to for validating clinical findings.

Another important investigation area for the future is the newer zirconia materials like high translucency zirconia on bonding behavior and the cement performance. As material properties continue to advance it is necessary to evaluate the effectiveness of current cementation protocols.

Moreover, standardization of testing methods in in vitro studies would improve comparability between studies and allow for more reliable conclusions. Variations in testing protocols, like

differences in surface treatment, aging procedures, and bond strength measurement techniques, currently limit the ability to draw consistent conclusions across studies.

5. CONCLUSIONS

1. Resin-based cements demonstrated higher bond strength to zirconia compared to phosphate cement, based on the findings of in vitro studies.
2. Zirconia crowns cemented with both resin-based and phosphate cement showed satisfactory clinical longevity, with no clear evidence of superiority of one cement type over the other based on available clinical studies.
3. Failure rates of zirconia crowns were generally low regardless of the cementation method used, although limited data were available for phosphate cement.

Future studies should focus on direct comparisons between different cement types, including well-designed clinical trials with long-term follow-up. Certain research would provide a clearer understanding of the role of cement selection in the success of zirconia crowns and help guide evidence-based clinical decision-making.

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7. CONFLICT OF INTERESTS

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LSMU Bioetikos centras, įvertinęs pateiktus dokumentus, moksliniam-tiriamajam darbui tema „Comparison of phosphate cement and resin composite cement used for cementation of zirconia crowns in terms of bond strength, clinical longevity, and failure rate: a scientific literature review“ P R I T A R I A .

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