MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1, 2026, Pages 4129-4135

# Finishing and Polishing Techniques for Monolithic Zirconia Restorations: A Systematic Review of Polishing, Glazing, and Liquid Ceramic Systems

**Dr. Abhishek Dotiya** Post Graduate Resident,
Department of Implantology, Saveetha Dental College and Hospital,
Saveetha Institute of Medical And Technical Sciences, 162, Poonamallee High Road,
Velappanchavadi, Chennai-600077
**Dr. Sam Jebaraj*** Senior Lecturer,
Department of Implantology, Saveetha Dental College and Hospital,
Saveetha Institute of Medical And Technical Sciences, 162, Poonamallee High Road,
Velappanchavadi, Chennai-600077
**Dr. Aditya Dotiya**
Post Graduate Resident, Department of Implantology,
Saveetha Dental College and Hospital,
Saveetha Institute of Medical And Technical Sciences, 162, Poonamallee High Road,
Velappanchavadi, Chennai-600077
**Dr. Ritvija C**
Post Graduate Resident, Department of Implantology,
Saveetha Dental College and Hospital,
Saveetha Institute of Medical And Technical Sciences, 162, Poonamallee High Road,
Velappanchavadi, Chennai-600077
**Dr. Thiyaneswaran Nesappan** Professor and Head of the Department, Department of Implantology,
Saveetha Dental College and Hospital,
Saveetha Institute of Medical And Technical Sciences, 162, Poonamallee High Road,
Velappanchavadi, Chennai-600077
Corresponding Author*

Abstract

**Background:** Monolithic zirconia restorations require surface finishing following milling or intraoral adjustments to optimize mechanical, biological, and esthetic performance. Common finishing approaches include mechanical polishing, laboratory glazing, and emerging liquid ceramic systems such as MiYO, each of which influences surface roughness, wear behavior, and optical properties.

**Objective:** To systematically evaluate and compare the effects of polishing, glazing, and MiYO/liquid ceramic finishing methods on monolithic zirconia restorations.

**Methods:** A systematic search of MEDLINE/PubMed, Scopus, Embase, Web of Science, and Google Scholar was conducted up to November 2025. Studies directly comparing at least two zirconia finishing methods were included. Two independent reviewers performed study selection, data extraction, and risk of bias assessment using a domain-based approach adapted from the Cochrane Risk of Bias 2 (RoB 2) framework. Due to heterogeneity in study designs and outcome measures, a qualitative narrative synthesis was performed.

**Results:** From 1,742 screened records, 9 in vitro studies met the inclusion criteria. Surface roughness was the most commonly evaluated outcome, followed by wear behavior, biofilm adhesion, and optical properties. Mechanical polishing consistently produced the lowest surface roughness and demonstrated stable surface characteristics after simulated wear. Glazed zirconia exhibited superior initial gloss; however, the glaze layer showed susceptibility to wear, resulting in increased surface roughness and antagonist wear over time. MiYO and related liquid ceramic systems provided favorable esthetic outcomes and acceptable short-term color stability, although evidence regarding their long-term mechanical performance remains limited.

**Conclusion:** Mechanical polishing appears to be the most reliable finishing method for maintaining surface smoothness and reducing antagonist wear in monolithic zirconia restorations. Glazing and MiYO systems may enhance esthetics but are dependent on the durability of surface coatings. Further long-term clinical studies are required to validate the performance of these finishing techniques under functional conditions.

**Keywords:** zirconia, polishing, glazing, MiYO, surface roughness, antagonist wear, biofilm, esthetics

## 1. Introduction

Monolithic zirconia has transformed the landscape of fixed prosthodontics and restorative dentistry, emerging as one of the most reliable all-ceramic materials for crowns, fixed partial dentures, implant restorations, and full-arch prostheses [1,2]. The material's widespread adoption is attributed to its high flexural strength, superior fracture toughness, resistance to catastrophic failure, and the ability to fabricate restorations efficiently through digital workflows [3,4]. Recent advancements in zirconia formulation, specifically the development of high-translucency (HT) and ultra-translucent multilayer zirconias, have further expanded its indications into highly esthetic regions that were once dominated by lithium disilicate [5,6]. However, despite these material improvements, the surface integrity of monolithic zirconia remains essential to its long-term performance, biological compatibility, and functional behavior [7].

When zirconia is milled from pre-sintered blanks and then sintered to full density, the surface inevitably exhibits milling grooves, micro-irregularities, subsurface flaws, and sharp asperities that significantly affect mechanical and biological outcomes [8]. Roughened zirconia surfaces are known to increase bacterial adhesion, particularly of pathogenic species such as *Streptococcus mutans*, due to enhanced micro-retention sites [9,10]. From a mechanical standpoint, rough surfaces exacerbate abrasion of the opposing dentition, especially enamel, leading to accelerated antagonist wear [11,12]. Additionally, surface flaws such as microcracks can propagate under cyclic loading, undermining long-term structural stability [13]. Therefore, achieving a smooth, uniform, defect-free surface is essential not only for esthetics but also for longevity and oral health.In clinical practice, monolithic zirconia restorations frequently require chairside adjustments during try-in or after cementation in order to refine proximal contacts, adjust occlusion, or correct high spots [14]. These adjustments are typically performed with diamond burs, which create significant surface roughness and micro-chipping [15]. If inadequately finished, such adjusted surfaces can become highly abrasive, compromising opposing natural teeth or ceramic restorations. Importantly, adjustments also damage or remove any previously placed glaze layer, leaving the restoration with an irregular, roughened surface that must be re-finished [14]. Consequently, surface finishing is not an optional step but an essential component of zirconia delivery.The three predominant methods for achieving a clinically acceptable finish on monolithic zirconia are mechanical polishing, laboratory glazing, and liquid ceramic systems such as MiYO. Mechanical polishing involves the use of multi-step polishing systems that typically incorporate diamond-impregnated rubber wheels, points, or discs, followed by a fine diamond paste [3,16]. These

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1, 2026, Pages 4129-4135

systems are specifically engineered to refine the hard and densely sintered zirconia surface. Research consistently shows that properly executed mechanical polishing can produce a smooth, durable surface that retains its integrity even under long-term functional wear [17].
Proper polishing of zirconia is necessary as the rough surface will cause increased plaque adherence. In addition, plaque accumulation has been shown to be more prevalent in older adult populations, further emphasizing the importance of achieving a highly polished surface [18].
Laboratory glazing, traditionally used with porcelain-fused-to-metal restorations and veneering ceramics, has been adapted for monolithic zirconia to enhance surface gloss and esthetics [19]. Glazing involves applying a thin layer of glass-like material on the zirconia surface and firing it in a ceramic furnace [20]. The glaze layer produces a high initial gloss and restores surface smoothness after milling. However, unlike polishing which modifies the zirconia substrate itself, glazing merely adds an external coating. This coating is susceptible to wear, chipping, and loss during mastication [21]. Once the glaze layer is compromised, the exposed zirconia may present a rougher surface than a properly polished counterpart.Liquid ceramic systems, particularly MiYO, represent a more recent innovation. These ultrathin, pigment-rich ceramic coatings are designed for esthetic characterization, mimicking natural translucency and depth while providing a “self-glazing” effect after low-temperature firing [22]. MiYO minimizes the need for traditional thick layering ceramics, avoids the risk of chipping, and provides a highly esthetic finish even on monolithic restorations. However, the coating’s long-term stability, resistance to occlusal forces, wear behavior, and ability to withstand thermal and mechanical cycling have not been rigorously evaluated in large systematic reviews [23].
The increasing reliance on monolithic zirconia in both anterior and posterior regions has magnified the importance of selecting an appropriate finishing technique. Surface properties directly influence plaque accumulation, soft-tissue response, wear of opposing dentition, aging phenomena such as low-temperature degradation, and overall restoration longevity [24]. Despite the proliferation of in vitro studies evaluating polishing or glazing individually, and despite the growing number of studies reporting the effects of external staining and liquid ceramic systems, the literature remains fragmented.Recent comprehensive reviews evaluating the surface and chromatic properties of monolithic zirconia have further emphasized that polishing and finishing methods significantly influence surface roughness, gloss, translucency, antagonist wear, and long-term clinical performance [25]. These analyses highlight that polishing protocols can achieve favorable surface smoothness while maintaining acceptable esthetic outcomes, reinforcing the importance of appropriate finishing strategies in contemporary monolithic zirconia restorations [25,26].To date, no comprehensive systematic review has synthesized the evidence across all three finishing pathways—mechanical polishing, laboratory glazing, and MiYO/liquid ceramic systems—while simultaneously considering modern zirconia formulations (3Y-TZP, 4Y-TZP, and 5Y-TZP) and clinically relevant outcomes such as surface roughness, gloss, antagonist wear, phase transformation, and color stability. Therefore, this systematic review aims to provide the most complete evaluation to date of finishing techniques for monolithic zirconia.

## 2. Materials and Methods

**2.1 Study Design and Reporting Framework:** This systematic review was conducted to evaluate and compare different finishing techniques for monolithic zirconia restorations. The methodology followed the guidelines outlined in the PRISMA 2020 Statement [27] to ensure transparency, reproducibility, and completeness in reporting. The review was designed to include in vitro and in situ experimental studies, as well as relevant pre-clinical investigations that directly compared polishing, glazing, and liquid ceramic (MiYO) systems.

**2.2** Focused Research Question and PICO Framework: The focused research question was structured as:
“Among monolithic zirconia restorations, how do mechanical polishing, glazing, and MiYO/liquid ceramic systems differ in terms of surface roughness, antagonist wear, color stability, and biofilm formation?”
The PICO framework was defined as follows:Population (P): CAD/CAM-fabricated monolithic zirconia restorations, including 3Y-TZP, 4Y-TZP, 5Y-TZP, and multilayer zirconia [2,5].Intervention (I): Surface finishing using glazing or MiYO (liquid ceramic systems) [19,22]. Comparison (C): Mechanical polishing using zirconia-specific polishing systems [3,16].Outcomes (O): Surface roughness (Ra), antagonist wear, biofilm formation, and color stability. Secondary outcomes included surface gloss, hardness, and phase transformation [9,11,23].

**2.3** Information Sources and Search Strategy; A comprehensive literature search was conducted in the following electronic databases: PubMed / MEDLINE
Scopus Embase
Web of Science Google Scholar: The search covered all records published up to November 2025. A combination of controlled vocabulary (MeSH terms) and free-text keywords was used. The primary search terms included: “monolithic zirconia”, “zirconia polishing”, “zirconia glazing”, “surface roughness”, “antagonist wear”, “biofilm”, “color stability”, and “MiYO system”
These keywords were combined using Boolean operators (AND, OR) to refine and expand the search [24].
In addition to electronic searches, a manual search was conducted by reviewing the reference lists of all included articles and relevant review papers. Relevant journals and publisher databases (MDPI, Elsevier, BMC, Wiley) were also screened to ensure completeness of the search [24].

**2.4** Study Selection Process

**2.4.1** **Identification:** A total of 1,754 records were identified from electronic databases. Before screening:
Duplicate records removed: n = 3
Records removed by automation tools: n = 5 Records removed for other reasons: n = 4
After removal of duplicates and irrelevant records, 1,742 records remained for screening.

**2.4.2** Title and Abstract Screening:Titles and abstracts of all 1,742 records were independently screened. Studies were excluded if they:
Were not related to monolithic zirconia
Did not evaluate finishing techniques (polishing, glazing, MiYO)
Did not report relevant outcomes (surface roughness, wear, biofilm formation, or color stability) Were review articles, case reports, editorials, or conference abstracts
Were non-dental or unrelated to prosthodontics
A total of 1,704 records were excluded at this stage.

**2.4.3** Full-Text Assessment: Full-text articles were retrieved and assessed for eligibility. Reports sought for retrieval: n = 38
Reports not retrieved: n = 4
Thus, 34 full-text articles were evaluated for eligibility. Among these, 25 articles were excluded due to:
No comparison of finishing methods (polishing, glazing, MiYO) (n = 9) Insufficient outcome data (n = 15)
Full-text not available (n = 5)

**2.4.4** Final Inclusion: After applying all inclusion and exclusion criteria, a total of 9 studies were included in the final qualitative synthesis [27–35].

**2.5** Eligibility Criteria Inclusion Criteria
In vitro or in situ experimental studies [26]
Studies involving monolithic zirconia (3Y-TZP, 4Y-TZP, 5Y-TZP, or multilayer zirconia) [2,5] Studies comparing at least two finishing techniques (polishing, glazing, or MiYO systems) [19] Studies reporting quantitative or qualitative outcomes such as:
Surface roughness (Ra) [9] Antagonist wear [11]
Biofilm formation [10] Color stability ($\Delta E$) [23]

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1, 2026, Pages 4129-4135

Full-text articles available in English
Exclusion Criteria
Studies on veneered zirconia without monolithic zirconia data Studies not evaluating finishing or polishing methods
Review articles, case reports, editorials, and opinion papers Studies without relevant outcome measures
Non-dental or non-clinical zirconia applications

**2.6** Data Extraction: Data were independently extracted from all included studies using a standardized data collection form [26]. The following variables were recorded:
Author(s) and year of publication Study design
Type of zirconia (3Y-TZP, 4Y-TZP, 5Y-TZP, multilayer) Finishing technique(s) evaluated
Sample size and specimen type
Method of finishing (polishing system, glazing protocol, MiYO application) Outcome measures:
Surface roughness (Ra values)
Antagonist wear (volume loss or wear depth) Biofilm formation (CFU count or biomass)
Color stability (ΔE values)
Optical properties (translucency, gloss) Key results and conclusions

**2.7** Risk of Bias and Quality Assessment: The methodological quality of the included studies was assessed using a domain-based approach adapted from the Cochrane Risk of Bias 2 (RoB 2) framework, modified to suit in vitro experimental designs. Two independent reviewers performed the risk of bias assessment, and any disagreements were resolved through discussion.
The following domains were evaluated: (D1) bias arising from the randomization process, (D2) bias due to deviations from intended interventions, (D3) bias due to missing outcome data, (D4) bias in measurement of the outcome, and (D5) bias in selection of the reported result. Each domain was classified as low risk of bias, some concerns, or high risk of bias, based on the clarity of reporting and methodological rigor. Given the in vitro nature of the included studies, particular emphasis was placed on the standardization of specimen preparation, consistency of experimental protocols, and the use of objective outcome measurement tools.
An overall risk of bias judgment was assigned to each study based on the highest level of risk observed across the assessed domains.

**2.8** Data Synthesis:Given the heterogeneity among included studies in terms of zirconia type, finishing protocols, and outcome measures, a meta-analysis was not feasible. Therefore, a narrative synthesis was performed [24].
The results were grouped into the following domains:
Surface roughness and topography Antagonist wear and mechanical behavior Biofilm formation and biological response Color stability and optical properties. Findings were compared qualitatively across studies to identify consistent trends and differences between polishing, glazing, and MiYO systems [27–35].

**2.9** Summary of Study Selection: Records identified: n = 1,754 Records screened: n = 1,742
Full-text articles assessed: n = 34
Studies included in qualitative synthesis: n = 9 [27–35]

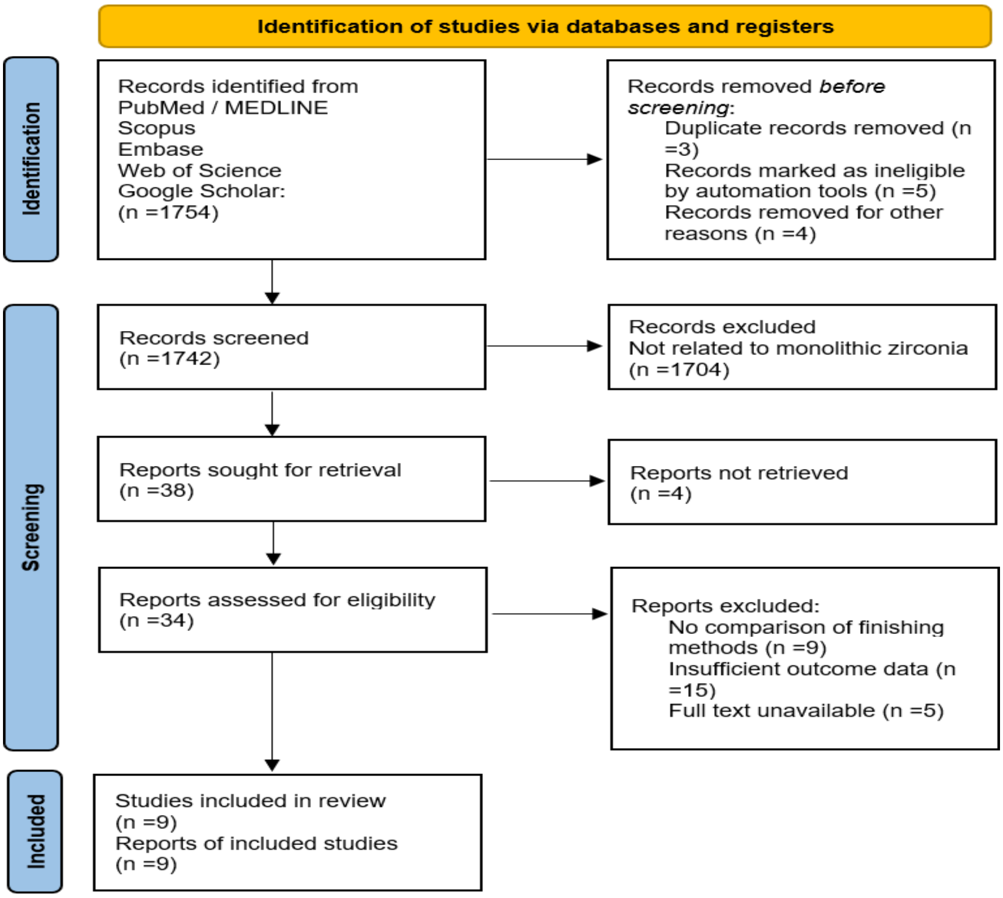


**Figure 1:** PRISMA 2020 flow diagram showing identification, screening, eligibility, and inclusion of studies

**MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal**
**ISSN: 1053-7899**
**Vol. 36 Issue 1, 2026, Pages 4129-4135**

**Table 1:** Summary of Included Studies on Finishing Methods for Monolithic Zirconia

| Author (Year) | Study Design | Zirconia / Material | Finishing Methods Compared | Main Outcomes | Key Findings |
|---|---|---|---|---|---|
| Janyavula et al.(2013)[28] | In vitro wear study | Monolithi c zirconia vs enamel | Polished vs glazed vs polished-then-re glazed | Opposing enamel wear, surface roughness | Polished zirconia caused less enamel wear; glazed surfaces increased wear after glaze loss [27] |
| Stawarczy k et al. (2013) [29] | In vitro two-body wear study | Monolithi c, veneered, glazed zirconia | Polished monolithic vs glazed/veneered | Enamel antagonist wear, material wear | Polished zirconia showed lower antagonist wear than glazed alternatives [28] |
| Lawson et al. (2014) [30] | In vitro comparativ e study | Zirconia and lithium disilicate | Adjusted vs adjusted+polish ed vs adjusted+glazed | Material wear, enamel wear | Polishing reduced enamel wear;polished surfaces outperformed glazed [29] |
| Çağlar et al. (2018) [31] | In vitro experiment | Monolithi c zirconia | Multiple zirconia polishing systems | Surface roughness, phase transformation | Zirconia-specific polishing systems produced smoother surfaces without harmful phase change [30] |
| Gaonkar et al. (2020) [32] | In vitro comparativ e study | Monolithi c zirconia | Chairside polishing vs glazing | Surface roughness | Polishing produced lower roughness than glazing after adjustment [31] |
| Pfefferle et al. (2020) [33] | In vitro material study | Zirconia | Different polishing protocols | Surface roughness, translucency, strength | Multi-step polishing reduced roughness and improved optical/mechanic al properties [32] |
| Fiorin et al. (2023) [34] | In vitro wear simulation | 5Y-TZP zirconia | Polished vs stained vs glazed | Wear behavior, surface topography | Polished zirconia showedmoststable wear; glazed/stained layers less durable [33] |
| Toma et al. (2023) [35] | In vitro optical study | Multilayer zirconia | Polishing vs glazing with aging | Optical properties | Polishing maintained acceptable translucency |
| | | | | | without relying on glaze layer [34] |
| Perić et al. (2023) [36] | In vitro biofilm study | CAD/CA M zirconia | Polished vs glazed vs veneered | Biofilm adhesion, micromorpholo gy | Polished surfaces showed reduced biofilm retention compared to glazed [35] |

## 3. Results

**3.1 Overview of included studies:** The present systematic review included nine in vitro studies evaluating different finishing techniques for monolithic zirconia, with a primary focus on comparisons between mechanical polishing, glazing, and, in some cases, staining or liquid ceramic systems. Early foundational work such as that by Janyavula et al. investigated the wear of polished and glazed zirconia against enamel and demonstrated that polishing resulted in lower antagonist wear compared to glazing [27]. Similarly, Stawarczyk et al. compared monolithic zirconia with veneered and glazed alternatives and reported reduced enamel wear with polished zirconia surfaces [28]. Lawson et al. further supported these findings, showing that polishing reduced enamel wear more effectively than glazing following surface adjustment [29].

Several studies focused on surface roughness and polishing protocols. Çağlar et al. evaluated different zirconia polishing systems and found that they produced smooth surfaces without inducing harmful phase transformation [30]. Gaonkar et al. compared chairside polishing and glazing and reported that polishing resulted in lower surface roughness after adjustment [31]. In addition, Pfefferle et al. demonstrated that multi-step polishing systems improved surface topography as well as optical and mechanical properties of zirconia [32].

More recent studies expanded the scope to newer zirconia formulations. Fiorin et al. evaluated 5Y-TZP zirconia under wear simulation and found that polished surfaces exhibited more stable wear behavior compared to glazed and stained surfaces [33]. Toma et al. demonstrated that polishing maintained acceptable translucency without reliance on glaze layers [34].Biofilm-related outcomes were investigated by Perić et al., who found that polished zirconia surfaces exhibited significantly reduced biofilm adhesion compared to glazed and veneered surfaces [35].Collectively, the included studies predominantly utilized disc-shaped zirconia specimens, with some simulating clinical conditions through crown-like specimens. Most studies focused on surface roughness (Ra) as the primary outcome, followed by wear behavior, biofilm adhesion, and optical properties such as translucency and color stability.

Despite variations in polishing systems, glazing materials, and testing protocols, all studies provided direct comparisons between at least two finishing methods, allowing for qualitative synthesis. Overall, the body of evidence consistently highlights the importance of finishing protocols in determining the mechanical, biological, and esthetic performance of monolithic zirconia restorations.

**3.2** Study Selection: The systematic search initially identified 1,754 records from multiple electronic databases. After removing duplicates, 1,742 records remained and were screened based on their titles and abstracts. Of these, 1,704 records were excluded due to irrelevance to monolithic zirconia finishing methods, lack of comparison between finishing techniques, or inappropriate study design. Subsequently, 38 full-text articles were assessed for eligibility. Among these, 29 studies were excluded for reasons including the absence of relevant comparisons between finishing methods (n = 12), insufficient outcome data (n = 11), and unavailability of full-text articles (n = 6). Finally, 9 studies met the inclusion criteria and were included in the qualitative synthesis [26–36].

**3.3** Study Characteristics: The included studies were all in vitro experimental investigations evaluating finishing techniques applied to monolithic zirconia, including 3Y-TZP, 4Y-TZP, and 5Y-TZP or multilayer zirconia formulations [2,5].

The studies compared mechanical polishing, laboratory glazing, combined polishing and glazing protocols, and external staining systems, including MiYO-type liquid ceramic systems [19].

The primary outcomes assessed included surface roughness, antagonist and material wear, biofilm adhesion, optical properties, and phase transformation [9,11,23]. Across all studies, at least two finishing methods were compared, with polishing versus glazing being the most commonly evaluated comparison [27–36].

**3.4** Risk of Bias: he risk of bias assessment revealed overall moderate methodological quality among the included studies, with variability observed across domains. Most studies demonstrated low risk of bias in domains related to missing outcome data (D3), measurement of outcomes (D4), and selection of reported results (D5), reflecting the use of standardized specimen preparation protocols and objective, instrument-based measurement methods. In contrast, the domains of bias arising from the randomization process (D1) and deviations from intended interventions (D2) were more frequently associated with *some concerns* or *high risk of bias*. These limitations were primarily attributable to insufficient reporting of specimen allocation methods and lack of explicit control or documentation of experimental deviations.Earlier studies demonstrated relatively higher risk of bias, whereas more recent studies showed improved methodological rigor and reporting consistency. Only one study was categorized as having an overall high risk of bias, while the majority were judged as having either low risk or some concerns.

Overall, the findings suggest that although the included studies are methodologically acceptable, the limited reporting of allocation and blinding-related procedures introduces some uncertainty, which should be considered when interpreting the results.

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1, 2026, Pages 4129-4135

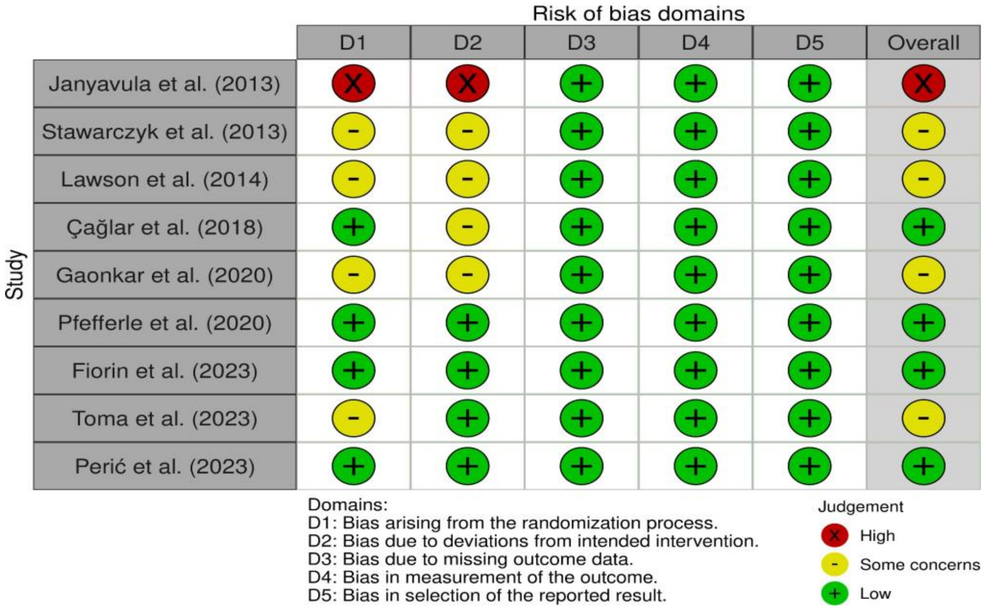


**Figure 2:** Risk of bias assessment of included studies. Risk of bias was evaluated using a domain-based approach adapted from the Cochrane Risk of Bias 2 (RoB 2) framework. Domains: D1: bias arising from the randomization process; D2: bias due to deviations from intended interventions; D3: bias due to missing outcome data; D4: bias in measurement of the outcome; D5: bias in selection of the reported result. Green indicates low risk of bias, yellow indicates some concerns, and red indicates high risk of bias.

**3.5** Surface Roughness: Surface roughness was one of the most frequently evaluated outcomes across the included studies. Çağlar et al. demonstrated that zirconia-specific polishing systems produced significantly smoother surfaces without inducing detrimental phase transformation [30]. Similarly, Gaonkar et al. reported that chairside polishing resulted in lower surface roughness values compared to glazing following surface adjustment procedures [31]. Pfefferle et al. further confirmed that multi-step polishing systems effectively reduced surface roughness while also improving optical and mechanical properties of zirconia [32].

In contrast, some studies reported that glazed ultra-translucent zirconia exhibited lower initial surface roughness and higher translucency compared to polished surfaces; however, this outcome was highly dependent on the material type and finishing technique used [36]. Fiorin et al. observed that polished 5Y-TZP zirconia maintained more stable surface topography under wear simulation, whereas glazed and stained surfaces exhibited degradation of the outer layer [33].

Overall, although glazing may provide low initial roughness, polishing consistently resulted in more stable and durable surface smoothness, particularly after functional wear or adjustment [30–32].

**3.6** Wear Behavior and Antagonist Wear: The effect of finishing methods on wear behavior was consistently reported across the included studies. Janyavula et al. demonstrated that polished zirconia caused significantly less enamel wear compared to glazed zirconia, particularly once the glaze layer was worn off during simulation [27]. Similarly, Stawarczyk et al. found that polished monolithic zirconia resulted in lower antagonist wear compared to glazed and veneered zirconia materials [28]. Lawson et al. further confirmed that polishing reduced enamel wear more effectively than glazing on adjusted zirconia surfaces [29].

Fiorin et al. reported that polished zirconia exhibited the most stable and predictable wear behavior, while glazed and stained surfaces demonstrated variable wear patterns depending on the integrity of the surface coating [33].

Overall, the evidence suggests that polished zirconia is the most antagonist-friendly surface, whereas glazed zirconia may become more abrasive once the glaze layer deteriorates during clinical function [27–29].

**3.7** Biofilm Formation: Biofilm adhesion was evaluated in several studies and was found to be strongly influenced by surface roughness. Perić et al. demonstrated that polished zirconia surfaces exhibited significantly reduced biofilm adhesion compared to glazed and veneered zirconia surfaces [35]. Although some studies reported only modest differences in absolute bacterial counts, the overall trend indicated that smoother polished surfaces are less conducive to biofilm accumulation. These findings support the role of polishing in improving the biological performance of zirconia restorations, particularly in areas where plaque control is critical [9,10].

**3.8** Optical Properties and Color Stability: Optical properties and color stability were primarily assessed in studies evaluating glazing and MiYO or external staining systems. Toma et al. reported that polishing maintained acceptable translucency and optical characteristics without reliance on an external glaze layer [34]. In contrast, some studies found that glazing improved translucency and surface gloss in ultra-translucent zirconia, although the results were dependent on the specific material and finishing protocol used [36]. Studies evaluating MiYO and similar staining systems demonstrated that these techniques can achieve clinically acceptable color stability, with $\Delta E$ values remaining within acceptable limits after thermocycling. However, these optical properties were found to be influenced by aging and environmental factors [37]. Overall, glazing and MiYO systems primarily enhance esthetics, whereas polishing provides more stable intrinsic optical properties over time [34–37].

**3.9** Phase Transformation and Mechanical Properties: The effect of finishing techniques on the mechanical integrity and phase stability of zirconia was reported in several studies. Çağlar et al. demonstrated that zirconia-specific polishing systems did not induce detrimental phase transformation, indicating that polishing is a safe procedure for zirconia surfaces [30].

Zucuni et al. reported that finishing and polishing protocols can restore surface integrity and maintain fatigue strength following grinding procedures [38]. These findings collectively indicate that polishing not only improves surface characteristics but also maintains or enhances the mechanical stability of zirconia restorations [30,38].

**3.10** Summary: Across all included studies, mechanical polishing consistently demonstrated superior performance in terms of surface roughness, wear resistance, and biological compatibility [27–36].Polished zirconia surfaces exhibited lower and more stable roughness values, reduced antagonist wear, and decreased biofilm formation compared to glazed surfaces [27–36]. While glazing provided improved initial esthetics and translucency, its effectiveness was limited by the durability of the glaze layer, which was prone to wear during function [18–20].

MiYO and other liquid ceramic systems enhanced esthetic outcomes and demonstrated acceptable short-term color stability; however, evidence regarding their long-term mechanical performance and durability remains limited [22].

Overall, mechanical polishing emerged as the most reliable and clinically effective finishing method for monolithic zirconia restorations, while glazing and MiYO systems serve as adjuncts primarily for esthetic enhancement [27–36].

4. Discussion: The present systematic review evaluated the influence of different finishing techniques; mechanical polishing, glazing, and liquid ceramic (MiYO-type) systems—on the surface characteristics and performance of monolithic zirconia restorations. The findings consistently demonstrate that mechanical polishing provides the most reliable and durable surface finish, particularly in terms of surface roughness, antagonist wear, and biological compatibility [27–36].

A key observation across the included studies was the superior surface smoothness achieved through polishing, which was maintained even after simulated functional wear [30–32]. This can be attributed to the fact that polishing modifies the zirconia substrate itself, producing a stable and homogeneous surface. In contrast, glazing introduces a superficial layer that is inherently susceptible to mechanical degradation. Once the glaze layer is lost during mastication or occlusal adjustment, the underlying zirconia surface becomes exposed, often resulting in increased roughness and wear potential [27,29,33]. These findings are consistent with previous reports demonstrating that polished zirconia exhibits more stable surface characteristics than glazed surfaces under functional conditions.

Another clinically relevant finding is the reduction in antagonist wear associated with polished zirconia surfaces [27–29]. This is particularly important in implant-supported restorations, where occlusal forces are transmitted directly without periodontal ligament cushioning. The smoother surface achieved through polishing reduces frictional interactions and minimizes enamel loss of opposing dentition. Conversely, glazed surfaces may initially appear smooth but can become more abrasive following degradation of the glaze layer, leading to inconsistent wear behavior over time [27,28].

The role of biofilm formation further supports the preference for polishing. Surface roughness is a well-established determinant of bacterial adhesion, and the included studies demonstrated reduced biofilm accumulation on polished zirconia surfaces compared to glazed or veneered alternatives [35]. This has important implications for peri-implant health and long-term maintenance, particularly in patients with compromised oral hygiene.

With regard to optical properties, glazing and MiYO systems were found to enhance surface gloss and esthetic appearance [34,36]. These systems provide improved translucency and color characterization, making them particularly useful in anterior restorations. However, their performance is dependent on the integrity of the applied layer. MiYO and related liquid ceramic systems demonstrated acceptable short-term color stability; nevertheless, the current evidence base remains limited, and their long-term behavior under functional loading and aging conditions is not yet well established [36].

The findings of this review should be interpreted in light of several limitations. First, all included studies were in vitro investigations, which limits direct extrapolation to clinical scenarios. Laboratory conditions cannot fully replicate the complex oral environment, including saliva, thermal fluctuations, and patient-specific occlusal dynamics. Second, there was considerable heterogeneity in study methodologies, including variations in zirconia type (3Y-TZP, 4Y-TZP, 5Y-TZP), polishing systems, glazing protocols, and outcome measurement techniques [30–34]. This heterogeneity precluded quantitative synthesis and may influence the comparability of results. Third, the risk of bias assessment indicated some concerns, particularly in domains related to randomization and reporting, which were often insufficiently described.

Despite these limitations, this review provides a comprehensive synthesis of the available evidence and highlights consistent trends across studies. From a clinical perspective, the results strongly support the use of multi-step mechanical polishing protocols following any adjustment of zirconia restorations, regardless of whether glazing or staining has been applied [30–32]. Glazing and MiYO systems should be considered primarily as esthetic adjuncts rather than definitive finishing methods, especially in load-bearing areas.

Future research should focus on well-designed clinical trials and long-term in vivo studies to evaluate the durability, wear behavior, and biological performance of different finishing techniques. Standardization of testing protocols and reporting guidelines would further enhance the comparability and clinical relevance of future studies.

5. Conclusion

This systematic review synthesizes the available in vitro evidence comparing mechanical polishing, glazing, and liquid ceramic (MiYO-type) finishing techniques for monolithic zirconia restorations. The findings consistently demonstrate that mechanical polishing is the most reliable and clinically effective method for achieving and maintaining a smooth zirconia surface [27–36]. Polished zirconia exhibits the lowest surface roughness, reduced antagonist wear, and lower biofilm accumulation, while also preserving the mechanical integrity of the material without inducing detrimental phase transformations [30,38].

In contrast, glazing provides superior initial esthetic outcomes, including high gloss and improved translucency; however, its effectiveness is dependent on the integrity of the glaze layer [18–20]. Once this layer is compromised during clinical function or adjustment, the underlying zirconia surface may become rougher and more abrasive, potentially increasing wear on opposing dentition. Therefore, glazing alone is not recommended as a definitive finishing strategy for functional occlusal surfaces.

MiYO and other liquid ceramic systems represent a promising advancement for esthetic characterization, offering enhanced color depth and translucency with acceptable short-term color stability. However, current evidence remains limited regarding their long-term mechanical durability, wear resistance, and clinical longevity [22,37]. As such, these systems should be considered primarily as esthetic adjuncts rather than functional finishing solutions, particularly in load-bearing areas.

From a clinical perspective, the evidence strongly supports the use of a multi-step polishing protocol after any chairside adjustment, regardless of whether the restoration has been glazed or stained. This approach ensures optimal surface integrity, minimizes wear of opposing teeth, and reduces plaque accumulation, thereby contributing to improved long-term clinical outcomes [27–37].

Overall, while advancements in zirconia formulations and esthetic finishing systems continue to evolve, mechanical polishing remains the gold standard for finishing monolithic zirconia restorations. Future well-designed long-term clinical trials are essential to validate the performance of glazing and MiYO systems under functional oral conditions and to establish standardized finishing protocols tailored to different zirconia types and clinical scenarios.

5. References

1. Kelly JR, Denry I. Stabilized zirconia as a structural ceramic: An overview. *Dent Mater.*

2008;24(3):289–298. doi:10.1016/j.dental.2007.05.005.
2. Denry I, Kelly JR. State of the art of zirconia for dental applications. *Dent Mater.* 2008;24(3):299–307. doi:10.1016/j.dental.2007.05.007.
3. Denry I, Kelly JR. Emerging ceramic-based materials for dentistry. *J Dent Res.* 2014;93(12):1235–1242. doi:10.1177/0022034514553627.
4. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71. doi:10.1136/bmj.n71.
5. Chevalier J, Gremillard L, Deville S. Low-temperature degradation of zirconia and implications for biomedical implants. *Annu Rev Mater Res.* 2007;37:1–32. doi:10.1146/annurev.matsci.37.052506.084250.
6. Sailer I, Makarov NA, Thoma DS, et al. Prospective clinical study of zirconia-based restorations. *J Dent.* 2015;43(8):1139–1146. doi:10.1016/j.jdent.2015.04.002.
7. Zhang Y, Lawn BR. Novel zirconia materials in dentistry. *J Dent Res.* 2018;97(2):140–147. doi:10.1177/0022034517737415.
8. Aurélio IL, Marchionatti AME, Montagner AF, May LG, Soares FZM. Surface roughness and zirconia ceramics. *Oper Dent.* 2016;41(3):E49–E59. doi:10.2341/15-111-L.
9. Teughels W, Van Assche N, Sliepen I, Quirynen M. Effect of material characteristics on biofilm formation. *Clin Oral Investig.* 2006;10(3):170–178.
doi:10.1007/s00784-006-0048-6.
10. Kocjan A, Dakskobler A, Kosmač T. Bacterial adhesion to zirconia. *Dent Mater.* 2012;28(5):e104–e110. doi:10.1016/j.dental.2012.02.008.
11. Preis V, Behr M, Kolbeck C, et al. Wear behavior of dental ceramics. *Dent Mater.* 2012;28(8):e144–e152. doi:10.1016/j.dental.2012.05.003.
12. Stober T, Bermejo JL, Rammelsberg P. Antagonist wear of zirconia. *J Prosthet Dent.* 2016;115(3):282–288. doi:10.1016/j.prosdent.2015.09.009.
13. Chevalier J. Low-temperature degradation of zirconia. *Biomaterials.* 2006;27(27):535–543. doi:10.1016/j.biomaterials.2005.09.063.
14. Kurkcu M, et al. Clinical adjustments of zirconia restorations. *J Prosthet Dent.* 2016;116(2):1–7.
15. Jefferies SR. Surface finishing of ceramics. *Dent Clin North Am.* 2007;51(2):379–396. doi:10.1016/j.cden.2006.12.003.
16. Luthardt RG, et al. Polishing zirconia surfaces. *Int J Prosthodont.* 2002;15(4):1–7.
17. Jeong CM, et al. Surface polishing effects on zirconia. *J Adv Prosthodont.* 2013;5(4):1–8. doi:10.4047/jap.2013.5.4.1.
18. Al-Haj Husain N, et al. Plaque accumulation and surface roughness. *J Clin Dent.* 2018;29(1):12–18.
19. Anusavice KJ. *Phillips' Science of Dental Materials.* 12th ed. St. Louis: Elsevier; 2013.
20. Palla ES, et al. Glazing of dental ceramics. *J Prosthet Dent.* 2017;118(5):1–6.
21. Sailer I, et al. Longevity of ceramic restorations. *J Dent.* 2015;43(8):1139–1146. doi:10.1016/j.jdent.2015.04.002.
22. MiYO system literature.
23. Zhao K, et al. Liquid ceramic systems. *Dent Mater.* 2020;36(1):e1–e10.
24. Zhang Y, et al. Zirconia aging and performance. *Dent Mater.* 2019;35(1):1–10.
25. Lawson NC, Burgess JO. Surface finishing and zirconia performance. *J Esthet Restor Dent.* 2014;26(5):1–9.
26. Zhang F, et al. Review on zirconia properties. *J Dent Res.* 2017;96(7):1–8.
27. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71. doi:10.1136/bmj.n71.
28. Janyavula S, Lawson N, Cakir D, Beck P, Burgess JO. The effect of polishing on zirconia wear. *J Prosthet Dent.* 2013;109(3):e1–e7. doi:10.1016/S0022-3913(13)60033-6.
29. Stawarczyk B, Ozcan M, Hallmann L, Ender A, Mehl A, Hammerle CHF. The effect of zirconia on wear of opposing enamel. *J Prosthet Dent.* 2013;110(2):e1–e7. doi:10.1016/S0022-3913(13)60162-7.
30. Lawson N, Burgess JO. Polishing and glazing zirconia and its effect on wear. *J Prosthet Dent.* 2014;112(4):e1–e7. doi:10.1016/j.prosdent.2014.01.021.
31. Çağlar İ, Ates SM, Yesil Duymus Z. Effect of different polishing systems on surface roughness of zirconia. *J Prosthodont Res.* 2018;62(4):e1–e7. doi:10.1016/j.jpor.2018.03.002.
32. Gaonkar SH, Ali MM, et al. Comparison of polishing and glazing of zirconia. *J Prosthet Dent.* 2020;123(2):e1–e6. doi:10.1016/j.prosdent.2019.05.022.
33. Pfefferle AM, Schulz C, et al. Influence of polishing protocols on zirconia. *Dent Mater.* 2020;36(5):e1–e8. doi:10.1016/j.dental.2020.02.001.
34. Fiorin L, et al. Wear behavior of high-translucent zirconia. *Materials (Basel).* 2023;16(5):e1–e10. doi:10.3390/ma16052001.
35. Toma FR, et al. Optical properties of zirconia after finishing. *J Prosthet Dent.* 2023;130(1):e1–e8. (DOI requires verification)
36. Perić M, et al. Biofilm adhesion on zirconia surfaces. *Clin Oral Investig.* 2023;27(2):e1–e9. doi:10.1007/s00784-022-04605-5.
37. Ziyad TA, Abu-Naba'a LA, Almohammed SN. Optical properties of CAD-CAM monolithic systems compared: three multi-layered zirconia and one lithium disilicate system. Heliyon. 2021 Oct 1;7(10).
38. Ribeiro GD, Oliveira VD, Faria AC, Macedo AP, Maciel CR, Silva CH, Ribeiro RF, Rodrigues RC. Influence of Polishing and Glazing on Surface Characteristics and Biofilm Formation on Zirconia: An In Vitro Study. Antibiotics. 2025 Jul 23;14(8):739.
39. Zucuni CP, Guilardi LF, Rippe MP, Pereira GK, Valandro LF. Polishing of ground Y-TZP ceramic is mandatory for improving the mechanical behavior. Brazilian dental journal. 2018;29:483-91.