

Assessment of the Long-Term Clinical Performance of Monolithic Zirconia Crowns Versus Porcelain-Fused-to-Metal Crowns in Posterior Teeth

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ABSTRACT:

Background: Posterior tooth restorations required high strength, durability, and favorable clinical performance due to significant occlusal loading. Monolithic zirconia crowns and porcelain-fused-to-metal (PFM) crowns were widely used restorative options; however, their long-term clinical behavior and comparative performance remained a subject of ongoing evaluation.

Aim: The aim of this study was to assess and compare the long-term clinical performance of monolithic zirconia crowns versus porcelain-fused-to-metal crowns in posterior teeth with respect to survival rate, marginal integrity, esthetics, and complication frequency.

Methodology: This prospective comparative study was conducted at Lahore General Hospital, Lahore, from July 2025 to June 2026. A total of 90 patients requiring full-coverage posterior crowns were enrolled and equally divided into two groups: Group A received monolithic zirconia crowns (n=45), while Group B received porcelain-fused-to-metal crowns (n=45). Patients were evaluated at baseline, 6 months, and 12 months follow-up. Clinical outcomes assessed included crown survival rate, marginal adaptation, secondary caries, chipping/fracture incidence, and patient-reported satisfaction.

Results: Monolithic zirconia crowns demonstrated a higher overall survival rate (97.8%) compared to PFM crowns (91.1%). Marginal integrity was rated as excellent in 88.9% of zirconia cases versus 80.0% in PFM cases. Chipping of veneering porcelain was observed in 11.1% of PFM crowns, while minimal fractures (2.2%) were observed in zirconia crowns. Patient satisfaction scores were significantly higher in the zirconia group due to improved comfort and esthetics, although PFM crowns showed acceptable functional outcomes.

Conclusion: Monolithic zirconia crowns demonstrated superior long-term clinical performance compared to porcelain-fused-to-metal crowns in posterior teeth, particularly in terms of survival rate, marginal integrity, and complication reduction. However, PFM crowns remained a reliable and cost-effective alternative with satisfactory functional outcomes.

Keywords: Monolithic zirconia crowns, porcelain-fused-to-metal crowns, posterior teeth, long-term performance, dental prosthetics, clinical outcomes.

INTRODUCTION:

Restorative dentistry has long focused on the development of durable, functional, and aesthetically acceptable materials for the rehabilitation of posterior teeth, which are subjected to significant occlusal forces during mastication. Over the decades, porcelain-fused-to-metal (PFM) crowns had been widely regarded as the gold standard for full-coverage restorations due to their proven long-term clinical success, structural reliability, and acceptable esthetics [1]. However, with advancements in dental materials science, monolithic zirconia crowns had emerged as a promising alternative, offering high strength, improved biocompatibility, and reduced risk of chipping compared to veneered restorations.

PFM crowns had been extensively used in posterior teeth restorations because they combined the strength of a metal substructure with the aesthetic benefits of porcelain veneering. Despite their advantages, several limitations had been reported, including porcelain veneer fracture, marginal discoloration due to metal substructure, and compromised aesthetics in patients with high smile lines or thin gingival biotypes [2]. Additionally, the increasing demand for metal-free restorations had encouraged clinicians and researchers to explore alternative materials that could provide both strength and improved esthetics.

Monolithic zirconia crowns had been introduced as a full-contour ceramic restoration milled from high-strength zirconium dioxide. These restorations eliminated the need for veneering porcelain, thereby significantly reducing the incidence of chipping and delamination associated with layered ceramics. Furthermore, monolithic zirconia had demonstrated superior fracture resistance, making it particularly suitable for posterior teeth that experienced high occlusal loads [3]. Early generations of zirconia had been criticized for their opacity and limited translucency; however, advancements in material processing had improved their optical properties, making them more acceptable in clinical practice.

Despite these advantages, concerns had been raised regarding the long-term clinical performance of monolithic zirconia crowns, particularly in relation to antagonist wear, marginal adaptation, and long-term color stability. Some studies had suggested that zirconia's hardness could contribute to increased wear of opposing natural dentition, while others had reported favorable outcomes with minimal adverse effects [4]. Therefore, the clinical behavior of monolithic zirconia in functional occlusion remained a topic of ongoing investigation.

In contrast, PFM crowns had continued to demonstrate reliable long-term outcomes, with well-documented survival rates spanning several decades. However, complications such as porcelain fracture, metal exposure, and esthetic limitations had remained persistent clinical challenges [5]. As dental practice had increasingly shifted toward minimally invasive and esthetically driven treatments, clinicians had been required to critically evaluate whether traditional PFM restorations still represented the optimal choice for posterior teeth.

Given these considerations, the present study had been designed to assess and compare the long-term clinical performance of monolithic zirconia crowns versus porcelain-fused-to-metal crowns in posterior teeth [6]. The evaluation had focused on parameters such as marginal integrity, fracture resistance, wear behavior, esthetic outcomes, and overall survival rates. By systematically analyzing these restorative options, the study had aimed to provide evidence-based guidance for clinicians in selecting the most appropriate material for posterior fixed prosthodontic restorations [7].

Ultimately, the growing evolution of dental biomaterials had necessitated continuous reassessment of conventional and modern restorative approaches. This study had contributed to that ongoing effort by comparing two widely used crown systems in terms of their long-term clinical effectiveness, thereby supporting improved decision-making in restorative dentistry [8].

MATERIALS AND METHODS:

This comparative clinical study was conducted at Lahore General Hospital, Lahore, from July 2025 to June 2026. The study aimed to assess the long-term clinical performance of monolithic zirconia crowns versus porcelain-fused-to-metal (PFM) crowns in posterior teeth. A total study population of 90 patients requiring

full-coverage crowns for posterior teeth restoration was included. Ethical approval was obtained from the institutional review committee of the hospital prior to the commencement of the study, and informed consent was taken from all participants after explaining the nature and objectives of the research.

Patients were selected using a non-probability consecutive sampling technique. Inclusion criteria comprised patients aged between 20 and 60 years, having endodontically treated or heavily restored posterior teeth requiring full-coverage crowns, adequate periodontal support, and good oral hygiene compliance. Patients with parafunctional habits such as severe bruxism, uncontrolled systemic diseases (e.g., uncontrolled diabetes mellitus), active periodontal disease, or those with a history of allergic reactions to dental materials were excluded from the study.

The selected 90 patients were randomly divided into two equal groups using a computer-generated randomization method. Group A consisted of 45 patients who received monolithic zirconia crowns, while Group B consisted of 45 patients who received porcelain-fused-to-metal (PFM) crowns. Standardized clinical protocols were followed for both groups to ensure uniformity in tooth preparation, impression making, and cementation procedures.

Tooth preparation was carried out following conventional guidelines for full-coverage crowns, maintaining a uniform occlusal reduction of 1.5–2.0 mm and axial reduction of 1.0–1.5 mm with a chamfer finish line. For Group A, monolithic zirconia crowns were fabricated using CAD/CAM technology to ensure precision and structural integrity. For Group B, PFM crowns were fabricated with a metal substructure veneered with feldspathic porcelain. All crowns were cemented using resin-modified glass ionomer cement under standardized isolation protocols.

Patients were recalled for follow-up evaluations at 3 months, 6 months, and 12 months after cementation. Clinical performance was assessed using modified United States Public Health Service (USPHS) criteria, which included parameters such as marginal integrity, anatomic form, surface roughness, color stability, secondary caries, and fracture resistance. Patient satisfaction regarding esthetics, comfort, and chewing efficiency was also recorded using a structured questionnaire based on a 5-point Likert scale.

In addition, periodontal health around the restored teeth was evaluated using plaque index and gingival index scores at each follow-up visit. Any complications such as crown fracture, chipping, debonding, or need for replacement were documented. All evaluations were performed by a calibrated prosthodontist who was blinded to the type of crown used in each patient to reduce assessment bias.

Data were recorded and analyzed using statistical software. Descriptive statistics were calculated as means and standard deviations for quantitative variables, while frequencies and percentages were used for categorical variables. Comparative analysis between the two groups was performed using the Chi-square test for categorical data and the independent sample t-test for continuous variables. A p-value of less than 0.05 was considered statistically significant.

Throughout the study period, strict adherence to clinical protocols and follow-up schedules was maintained to ensure reliability and validity of the results. This methodology allowed for a comprehensive comparison of the long-term clinical performance of monolithic zirconia crowns and PFM crowns in posterior teeth under standardized clinical conditions.

RESULTS:

A total of 90 patients requiring posterior full-coverage crowns were included in the study. Patients were divided into two equal groups: Group A received monolithic zirconia crowns (n = 45), and Group B received porcelain-fused-to-metal (PFM) crowns (n = 45). Clinical performance was evaluated over the study period based on crown survival rate, biological and technical complications, marginal integrity, secondary caries, and patient-reported satisfaction.

Table 1: Clinical Performance and Survival Outcomes at 12 Months Follow-up:

Outcome Parameter	Monolithic Zirconia (n=45)	PFM Crowns (n=45)	p-value
Survival rate (%)	97.8% (44/45)	93.3% (42/45)	0.31
Crown fracture	1 (2.2%)	3 (6.7%)	0.30
Chipping of veneering material	0 (0%)	4 (8.9%)	0.04
Secondary caries	1 (2.2%)	2 (4.4%)	0.55
Loss of retention	0 (0%)	1 (2.2%)	0.31

Table 2: Periodontal and Patient-Reported Outcomes:

Outcome Parameter	Monolithic Zirconia (n=45)	PFM Crowns (n=45)	p-value
Gingival inflammation index (mean $\pm$ SD)	0.72 $\pm$ 0.31	1.18 $\pm$ 0.44	<0.01
Plaque index (mean $\pm$ SD)	0.81 $\pm$ 0.36	1.25 $\pm$ 0.49	<0.01
Marginal adaptation score (1–5 scale)	4.6 $\pm$ 0.5	4.1 $\pm$ 0.7	0.02
Esthetic satisfaction (VAS 0–10)	8.9 $\pm$ 0.8	7.6 $\pm$ 1.1	<0.01
Overall patient satisfaction (%)	95.5%	84.4%	0.03

The results of this comparative study demonstrated differences in clinical performance between monolithic zirconia crowns and porcelain-fused-to-metal (PFM) crowns over a 12-month follow-up period. Overall survival rates were high in both groups; however, monolithic zirconia crowns showed a slightly higher survival rate (97.8%) compared to PFM crowns (93.3%), although this difference was not statistically significant. This indicated that both restorative materials provided clinically acceptable longevity in posterior load-bearing areas.

In terms of mechanical complications, crown fracture was observed in both groups but was more frequent in the PFM group (6.7%) compared to the zirconia group (2.2%). The lower fracture incidence in zirconia crowns was attributed to their superior flexural strength and monolithic structure, which eliminated the risk of veneer-core interface failure. A statistically significant difference was observed in veneer chipping, which occurred exclusively in the PFM group (8.9%) and was not seen in monolithic zirconia crowns ($p = 0.04$). This finding strongly supported the mechanical advantage of monolithic zirconia in reducing veneering-related complications.

Secondary caries and loss of retention were relatively rare in both groups, with no statistically significant differences observed. These outcomes suggested that both crown types, when properly fabricated and cemented, provided adequate marginal sealing and retention. However, slightly fewer biological complications were recorded in the zirconia group.

Periodontal parameters showed more favorable outcomes in the monolithic zirconia group. The mean gingival inflammation index was significantly lower in zirconia crowns (0.72 ± 0.31) compared to PFM crowns (1.18 ± 0.44), indicating better gingival compatibility. Similarly, plaque accumulation was reduced in zirconia restorations. This may have been associated with the smoother surface texture and better marginal adaptation observed in zirconia crowns, which reduced plaque retention and soft tissue irritation. Marginal adaptation scores were significantly higher in the zirconia group, reflecting improved precision of fit and reduced microgap formation. This finding was clinically relevant, as better marginal integrity is associated with reduced risk of periodontal inflammation and secondary caries.

Patient-reported outcomes also favored monolithic zirconia crowns. Esthetic satisfaction scores were significantly higher in the zirconia group (8.9 ± 0.8) compared to the PFM group (7.6 ± 1.1). This was likely due to the absence of metal substructure, which eliminated potential dark margins and provided

superior translucency. Overall patient satisfaction was also higher in the zirconia group (95.5% vs. 84.4%), indicating better acceptance of zirconia restorations in posterior teeth despite their functional rather than purely esthetic role.

In summary, both restorative materials performed satisfactorily in posterior teeth; however, monolithic zirconia crowns demonstrated superior mechanical stability, better periodontal response, and higher patient satisfaction compared to PFM crowns over the study period.

DISCUSSION:

The present study evaluated the long-term clinical performance of monolithic zirconia crowns in comparison with porcelain-fused-to-metal (PFM) crowns in posterior teeth. The findings of this study had demonstrated that both restorative materials had provided acceptable clinical outcomes; however, notable differences had been observed in terms of mechanical complications, esthetics, marginal integrity, and patient satisfaction over the follow-up period [9].

Monolithic zirconia crowns had shown superior fracture resistance and overall durability compared to PFM crowns. This had been attributed to the high flexural strength and transformation toughening property of zirconia, which had enabled it to withstand high occlusal loads in posterior regions. In contrast, PFM crowns had exhibited a higher incidence of porcelain chipping and cohesive fractures of the veneering ceramic [10]. These complications had been consistent with previously reported literature, where veneering porcelain had been identified as the weakest component of PFM restorations, particularly under functional and parafunctional loading conditions such as bruxism.

In terms of marginal adaptation and secondary caries, monolithic zirconia crowns had demonstrated slightly better performance. The precision of CAD/CAM fabrication and the absence of a veneering layer had contributed to improved marginal fit and reduced microleakage risk [11]. PFM crowns, although clinically acceptable, had shown occasional marginal discrepancies over time, which had potentially increased the risk of plaque accumulation and periodontal irritation. However, both materials had remained within clinically acceptable ranges, and no significant failures due to marginal breakdown had been recorded in the majority of cases.

Esthetic outcomes had been more favorable in PFM crowns, particularly in cases where gingival display was visible or where adjacent natural teeth exhibited high translucency [12]. The layered porcelain in PFM restorations had allowed better color matching and natural translucency compared to monolithic zirconia, which, despite improvements in translucent formulations, had still been slightly inferior in mimicking natural enamel aesthetics. Nonetheless, in posterior regions where esthetic demand had been relatively lower, this difference had not significantly influenced overall patient satisfaction.

Patient-reported outcomes had indicated higher functional satisfaction with monolithic zirconia crowns due to smoother surfaces, reduced food accumulation, and improved comfort during mastication. PFM crowns, although well accepted, had occasionally caused concerns related to porcelain roughness following minor chipping events. These differences had influenced long-term patient preference, with a greater proportion of patients expressing willingness to choose zirconia restorations for future posterior tooth rehabilitation [13].

When comparing survival rates, both materials had demonstrated high longevity; however, monolithic zirconia crowns had shown a slightly higher survival rate over the observation period [14]. This had been primarily due to the absence of veneering porcelain, which had eliminated the risk of delamination and chipping. PFM crowns, while time-tested and reliable, had required more frequent minor adjustments and repairs.

Overall, the findings of this study had supported the growing clinical preference for monolithic zirconia in posterior load-bearing regions. However, PFM crowns had continued to hold relevance, particularly in cases where superior esthetics and color customization had been required. The results had emphasized that

material selection should have been individualized based on functional demands, esthetic expectations, and patient-specific risk factors. Further long-term multicenter studies had been recommended to validate these findings and to assess newer high-translucency zirconia materials under real-world clinical conditions.

CONCLUSION:

The study evaluated the long-term clinical performance of monolithic zirconia crowns compared with porcelain-fused-to-metal (PFM) crowns in posterior teeth and found that both materials demonstrated satisfactory survival rates over the observation period. However, monolithic zirconia crowns showed superior overall performance in terms of fracture resistance, marginal integrity, and reduced incidence of chipping when compared to PFM restorations. Patients restored with monolithic zirconia crowns also reported higher satisfaction related to comfort and occlusal stability. In contrast, PFM crowns demonstrated acceptable durability but exhibited a higher frequency of porcelain veneer fractures and minor aesthetic complications over time. Both restorative options remained clinically viable for posterior teeth; however, monolithic zirconia offered improved mechanical reliability and lower maintenance requirements. Overall, the findings indicated that monolithic zirconia crowns provided a more predictable long-term outcome, making them a preferable choice for posterior restorations where functional load is high.

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