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Original Article

Evaluation of Marginal Fit of Zirconia Crown Is More Accurate Than That of Porcelain-Fused-to-Metal (PFM) Crown

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Abstract

Background: Full coverage crowns remain a key restorative option for compromised or missing teeth, with marginal adaptation being critical for the longevity and success of the restoration. Therefore, the purpose of the present study is to compare the marginal fit of zirconia crowns with that of porcelain-fused-to-metal (PFM) crowns in endodontically treated teeth.

Methods: This comparative in vitro study at the Department of Prosthodontics, Bangabandhu Sheikh Mujib Medical University (BSMMU), in collaboration with Beau-Dent, Dhaka, Bangladesh (January–December 2021), included 60 endodontically treated teeth equally divided into zirconia and PFM crown groups. Marginal gaps at mesial, distal, buccal, and lingual surfaces were measured with a stereomicroscope and compared using SPSS 25, with $p < 0.05$ considered significant.

Results: Sixty endodontically treated teeth were equally assigned to zirconia (n = 30) and PFM (n = 30) groups. Participants had a mean age of 25.03 ± 2.76 years, with 56.7% females. Zirconia crowns showed significantly smaller mean marginal gaps (45.2 ± 5.8 µm) than PFM crowns (78.6 ± 9.4 µm, $p < 0.001$), with consistent gaps across all surfaces.

Conclusion: Zirconia crowns provide superior and more consistent marginal fit than PFM crowns in endodontically treated teeth, supporting their clinical reliability.

Key words: Marginal Fit, Zirconia Crown, PFM Crown

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Introduction

Full coverage crowns continue to be extensively utilized for the restoration of compromised teeth as well as for the replacement of missing teeth [1]. A fundamental principle in tooth preparation is the conservation of natural tooth structure, yet conventional PFM restorations require the removal of approximately 1.5–2.0 mm of dental tissue [2]. Contemporary restorative options, such as milled zirconia crowns, present multiple advantages over traditional metal-ceramic restorations, including enhanced aesthetics that closely resemble the natural dentition, superior biocompatibility that minimizes the risk of adverse tissue reactions, and increased durability, which contributes to extended clinical longevity [3]. Achieving an appropriate restoration for endodontically treated teeth is critical not only to preserve function and aesthetics but also to maintain the overall structural integrity of the tooth.

The accuracy of marginal adaptation plays a pivotal role in determining the long-term clinical success of dental restorations. Inadequate marginal fit may result in cement dissolution, microleakage, secondary caries, and periodon

tal inflammation, which can ultimately compromise the prosthetic outcome [4]. The degree to which a restoration precisely conforms to the prepared tooth margins—the marginal fit—is a key factor influencing the durability and success of fixed prostheses. Insufficient marginal adaptation can create micro-gaps that promote plaque accumulation and facilitate microleakage, potentially leading to complications such as secondary caries, pulpal irritation, and periodontal disease [5,6]. Therefore, achieving a precise and stable marginal seal is critical for the functional and biological longevity of the restoration [7].

Porcelain-fused-to-metal (PFM) crowns have been regarded as the benchmark in restorative dentistry for several decades, providing a reliable combination of strength and aesthetics and remaining widely employed in conventional clinical practice [8]. Yttria tetragonal zirconia polycrystal (Y-TZP) has emerged as a highly resilient material for fixed dental prostheses, offering superior fracture resistance and aesthetic performance when compared to PFM restorations [9]. Monolithic zirconia (MZ) crowns, which are fabricated from a single zirconia block without a veneering porcelain layer, have increasingly gained popularity due to their high flexural strength, wear resistance, and enhanced fracture toughness [10,11]. Both PFM and zirconia crowns can be applied in vertical tooth preparation techniques, which favor greater preservation of dental tissue; however, limited studies have evaluated their medium- and long-term clinical performance in this context [12].

Despite the documented advantages of zirconia crowns, evidence regarding their marginal adaptation relative to conventional PFM crowns remains varied. Reported values for optimal marginal fit show wide discrepancies, ranging from 7.5 µm to 313 µm, and there is no universal consensus on clinically acceptable thresholds [13,14]. Furthermore, research specifically evaluating full-contour zirconia restorations with different thicknesses remains limited [9], and there is a scarcity of long-term clinical data directly comparing monolithic zirconia and PFM crowns, particularly in endodontically treated teeth [15]. This variability and lack of definitive evidence highlight the necessity for further comparative studies to ascertain whether zirconia crowns consistently provide superior marginal adaptation over traditional PFM restorations. Therefore, the purpose of the present study is to compare the marginal fit of zirconia crowns with that of porcelain-fused-to-metal (PFM) crowns in endodontically treated teeth.

Objective

To compare the marginal fit of zirconia crowns with that of porcelain-fused-to-metal (PFM) crowns in endodontically treated teeth.

Methodology & Materials

This comparative in vitro study was conducted at the Department of Prosthodontics, Bangabandhu Sheikh Mujib Medical University (BSMMU), in collaboration with Beau-Dent, The Dental Specialist, Dhaka, Bangladesh, from January 2021 to December 2021. A total of 60 endodontically treated teeth were included, selected based on specific inclusion and exclusion criteria. The sample was equally divided into two groups, with 30 teeth restored using zirconia crowns and 30 teeth restored using porcelain-fused-to-metal (PFM) crowns, to evaluate and compare the marginal fit of the two crown types.

Inclusion Criteria:

- Endodontically treated teeth
- Structurally sound teeth
- Teeth free of cracks or fractures

Exclusion Criteria:

- Teeth with extensive coronal damage
- Teeth with severe periodontal compromise
- Teeth with previous prosthetic restorations

Crown Fabrication and Grouping:

- Zirconia Group (n = 30): Crowns were fabricated using CAD/CAM technology following standard preparation protocols.
- PFM Group (n = 30): Conventional metal-ceramic crowns were fabricated using the lost-wax casting technique and porcelain layering.

All crowns were fabricated to standard occlusal and marginal specifications and checked for passive fit prior to measurement.

Measurement of Marginal Fit:

The marginal gap of each crown was measured at four reference surfaces: mesial, distal, buccal, and lingual. A stereomicroscope with appropriate magnification was used for precise measurement, recorded in micrometers (µm). Mean marginal gap, standard deviation, and range were calculated for each crown type.

Data Collection and Analysis:

Demographic characteristics of participants, including age and gender, were recorded. All data were entered into SPSS version 25 for analysis. Descriptive statistics (mean, standard deviation, and range) were calculated for marginal gaps. Independent t-tests were performed to compare the mean marginal gaps between zirconia and PFM crowns. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1: Distribution of Study Sample by Crown Type (n = 60)

Group	Number of Teeth (n)	Percentage (%)
Zirconia	30	50.0
PFM	30	50.0
Total	60	100.0

The study sample comprised 60 endodontically treated teeth, equally allocated into two groups: 30 teeth (50.0%) restored with zirconia crowns and 30 teeth (50.0%) restored with porcelain-fused-to-metal (PFM) crowns.

Table 2: Demographic Characteristics of Study Participants (n = 60)

Variable		Zirconia Group (n=30)	PFM Group (n=30)	Total (N=60)
Age (Years)	20 – 24	14 (46.7%)	13 (43.3%)	27 (45.0%)
	25 – 30	16 (53.3%)	17 (56.7%)	33 (55.0%)
	Mean Age ± SD (years)	24.93 ± 2.79	25.12 ± 2.77	25.03 ± 2.76
Gender	Male	12 (40.0%)	14 (46.7%)	26 (43.3%)
	Female	18 (60.0%)	16 (53.3%)	34 (56.7%)

Participants were aged between 20 and 30 years, with the majority belonging to the 25–30-year age group (33 teeth, 55.0%). The overall mean age of the participants was 25.03 ± 2.76 years. Females constituted a slightly higher proportion of the sample (34 teeth, 56.7%) compared to males (26 teeth, 43.3%). In the zirconia group, 16 teeth (53.3%) belonged to the 25–30-year age group and 18 teeth (60.0%) were from female participants. In the PFM group, 17 teeth (56.7%) were aged 25–30 years and 16 teeth (53.3%) were from female participants.

Table 3: Mean Marginal Gap of Crowns

Crown Type	Mean Marginal Gap (µm)	Standard Deviation (SD)	Range (µm)
Zirconia	45.2	5.8	38 – 56
PFM	78.6	9.4	65 – 95

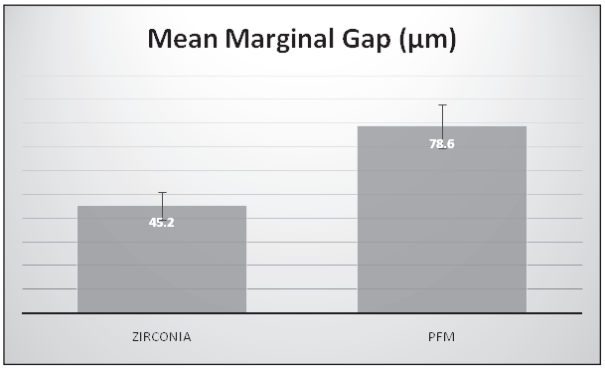
The mean marginal gap for zirconia crowns was 45.2 ± 5.8 µm (range 38–56 µm), whereas PFM crowns demonstrated a larger mean marginal gap of 78.6 ± 9.4 µm (range 65–95 µm).

Table 4: Marginal Gap at Reference Surfaces (Mean ± SD, µm)

Crown Type	Mesial	Distal	Buccal	Lingual
Zirconia	44.8 ± 5.2	45.5 ± 5.7	45.0 ± 6.0	45.5 ± 5.5
PFM	78.0 ± 9.2	80.1 ± 10.0	79.5 ± 8.7	76.8 ± 9.0

Surface-specific analysis demonstrated relatively consistent marginal gaps for zirconia crowns across the mesial (44.8 ± 5.2 µm), distal (45.5 ± 5.7 µm), buccal (45.0 ± 6.0 µm), and lingual (45.5 ± 5.5 µm) surfaces. In contrast, PFM crowns exhibited larger marginal gaps across all measured surfaces: mesial (78.0 ± 9.2 µm), distal (80.1 ± 10.0 µm), buccal (79.5 ± 8.7 µm), and lingual (76.8 ± 9.0 µm).

Figure 1: Comparison of Mean Marginal Gap Between Zirconia and PFM Crowns



Zirconia crowns demonstrated a smaller mean marginal gap (45.2 ± 5.8 µm) compared to PFM crowns (78.6 ± 9.4 µm). The difference between the two crown types was statistically significant ($p < 0.001$).

Discussion

In this comparative in vitro study conducted at the Department of Prosthodontics, Bangabandhu Sheikh Mujib Medical University, zirconia crowns demonstrated significantly smaller marginal gaps compared to porcelain-fused-to-metal (PFM) crowns across all reference surfaces. The findings indicate that zirconia restorations may provide a more accurate marginal fit for endodontically treated teeth, emphasizing their potential advantage in preserving tooth structure, preventing microleakage, and enhancing the longevity of prosthetic outcomes.

A total of 60 endodontically treated teeth were included in the study and were equally distributed between the two groups, with 30 teeth (50.0%) restored with zirconia crowns and 30 teeth (50.0%) restored with porcelain-fused-to-metal (PFM) crowns. This equal allocation ensured a balanced comparison between the two crown types and minimized potential bias that could arise from unequal sample sizes, thereby enhancing the reliability of the study outcomes.

The demographic characteristics of the participants further demonstrated a balanced distribution between the zirconia and PFM groups. The majority of teeth were within the 25–30-year age group (55.0%), with comparable proportions in both groups, and the overall mean age of the sample was 25.03 ± 2.76 years. Gender distribution showed a slight predominance of females (56.7%) compared with males (43.3%), with similar ratios observed in both treatment groups. These observations indicate that the baseline characteristics of the study population were comparable between the two groups, reducing potential demographic confounding in the evaluation of marginal fit. Similar results were reported by Khan et al.[16], who found no significant differences in age and gender distribution between zirconia and PFM restoration groups, supporting the importance of balanced demo

graphic profiles for valid comparative analyses. Such comparability strengthens the credibility of the present findings and ensures that differences observed in marginal adaptation are primarily attributable to the restorative material rather than patient-related variables.

The present study demonstrated that zirconia crowns exhibited a smaller mean marginal gap (45.2 ± 5.8 µm) compared with PFM crowns (78.6 ± 9.4 µm), highlighting the superior marginal adaptation of zirconia restorations. These results are consistent with the findings of Mohagheghet al.[17], who reported mean marginal gaps of approximately 42–45 µm for zirconia crowns, confirming excellent marginal fit. Similarly, Basunbulet al.[18] found that zirconia crowns fabricated using CAD/CAM technology generally had marginal gaps below 90 µm, which were considered clinically acceptable and often superior to conventional restorations. The marginal gap values observed in the present study are well within this clinically acceptable range and align closely with these prior observations, reinforcing the reliability of zirconia crowns in providing improved marginal precision compared with PFM restorations.

The surface-specific analysis further revealed that zirconia crowns maintained smaller and more uniform marginal gaps across all measured surfaces—mesial (44.8 ± 5.2 µm), distal (45.5 ± 5.7 µm), buccal (45.0 ± 6.0 µm), and lingual (45.5 ± 5.5 µm)—whereas PFM crowns exhibited larger gaps at corresponding surfaces. These results are in agreement with Dixit et al.[19], who reported zirconia marginal gaps around 37–38 µm across all four reference surfaces, while other crown materials showed higher discrepancies. Similarly, Basunbulet al.[18] confirmed that marginal gaps of zirconia crowns measured at multiple surfaces remained well below the clinically acceptable threshold of 90 µm, demonstrating consistent and reliable adaptation. The present findings thus reinforce the superiority of zirconia crowns in maintaining uniform marginal integrity across all surfaces, in contrast to PFM crowns, which displayed greater variability and larger marginal discrepancies.

Finally, the statistically significant difference observed in mean marginal gaps between zirconia (45.2 ± 5.8 µm) and PFM crowns (78.6 ± 9.4 µm, $p < 0.001$) is further supported by previous studies evaluating both in vitro and in vivo conditions. Mohammed et al.[20] reported significantly lower marginal discrepancies for CAD/CAM-fabricated zirconia crowns (~55.8 µm) compared with conventional PFM crowns (~109.7 µm, $p < 0.001$). Similarly, Paul et al.[21] found smaller mean marginal gaps for monolithic zirconia crowns (77.42 µm) relative to metal-ceramic restorations (95.86 µm), with significant differences between the groups. In agreement, Tekinet al.[22] reported that PFM crowns consistently exhibited higher marginal gaps than monolithic zirconia crowns, although all values remained within clinically acceptable limits. Collectively, these studies corroborate the present findings, confirming that zirconia crowns consistently provide more precise, reliable, and clinically favorable marginal adaptation compared with conventional PFM crowns.

Limitations of the study

The study had a few limitations:

- A relatively small sample size of teeth may limit the generalizability of the results.
- Only one type of zirconia and PFM crown system was evaluated, which may not represent all commercially available materials and fabrication methods.

Conclusion

Achieving an optimal marginal fit is crucial for the longevity and success of dental restorations, as it reduces the risk of microleakage and secondary caries. This study demonstrates that zirconia crowns provide superior marginal adaptation compared to porcelain-fused-to-metal (PFM) crowns in endodontically treated teeth. Zirconia restorations exhibited smaller and more consistent gaps across all measured surfaces, whereas PFM crowns showed larger gaps with greater variability. These findings suggest that zirconia crowns offer more precise adaptation, which may contribute to improved clinical performance and long-term restoration success.

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