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CLINICAL RESEARCH

# Long-term clinical outcomes of posterior monolithic and porcelain-fused zirconia crowns: A retrospective cohort study

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## ABSTRACT

**Statement of problem.** Monolithic zirconia crowns and porcelain-fused zirconia crowns have been evaluated with in vitro studies, but clinical evidence of their longevity is limited.

**Purpose.** The purpose of this retrospective cohort study was to compare the long-term cumulative survival and success rates of posterior monolithic and porcelain-fused zirconia crowns and to investigate risk factors associated with complications.

**Material and methods.** The study included 235 patients and 255 crowns (dropout rate:10.9%). Clinical data were analyzed for single posterior monolithic zirconia crowns and porcelain-fused zirconia crowns placed consecutively during a 10-year period and for subsequent events during follow-up. Survival curves for the monolithic zirconia crown and porcelain-fused zirconia crown groups were drawn using Kaplan-Meier analysis. Statistical differences between groups were tested using the log-rank test ($\alpha$=.05). The Cox proportional hazards analysis was used to identify risk factors for crown and abutment tooth complications.

**Results.** The 10-year cumulative survival rates of the monolithic zirconia crown and porcelain-fused zirconia crown groups were 86.0% (95% CI, 72.8 to 99.1%) and 71.0% (95% CI, 54.6 to 87.9%), respectively. The monolithic zirconia crown group had a higher survival rate than the porcelain-fused zirconia crown group, but the difference was not statistically significant (*P*=.108). The 10-year cumulative success rate was higher in the monolithic zirconia crown group than in the porcelain-fused zirconia crown group, but the difference was not statistically significant (*P*=.071). Two risk factors were identified for crown complications alone: a molar rather than premolar crown (*P*=.014, hazard ratio [HR]=6.012) and a maxillary rather than a mandibular crown (*P*=.003, HR=9.487).

**Conclusions.** The 2 different types of crowns exhibited application site dependency for crown complications but not for abutment tooth complications. (J Prosthet Dent 2025;133:1475-1483)

Metal-ceramic restorations have been widely and successfully used for over 60 years and have been considered the standard in restorative dentistry.[1,2] Nevertheless, metal-ceramic crowns may have a poor color match because of the metal substructure,[3] and allergies associated with gold- or cobalt chromium-based alloys have been reported.[4] Thus, ceramic metal-free restorations have become popular.[5,6] Among technologies for producing ceramic prostheses, the use of computer-aided design and computer-aided manufacturing (CAD-CAM) has expanded in the field.[7,8] A typical CAD–CAM-based zirconia restoration produces both high strength and satisfactory esthetics.[9] A systematic review indicated that porcelain-fused zirconia crowns (PFZCs) have a 5-year cumulative survival rate of 91.2%,[10] although fracturing of the veneering porcelain fractured has been reported in the molar region.[11] To eliminate this risk, translucent zirconia has been developed to produce monolithic zirconia crowns (MZCs) that are stronger and tougher than PFZCs.[12]

There are no conflicts of interest to disclose for this study.

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## Clinical Implications

Monolithic zirconia crowns and porcelain-fused zirconia crowns are reliable treatment options for prosthetic rehabilitation in posterior areas up to a mean observation period of 10 years.

The current MZC materials vary in flexural strength and translucency, with 3 types based on their yttria content: 3 mol% yttria-stabilized tetragonal zirconia polycrystal (3Y-TZP), 4 mol% yttria-TZP (4Y-TZP), and 5 mol% yttria-TZP (5Y-TZP).[9] Among these, 3Y-TZP was the first to be developed, offering the highest flexural strength but the lowest translucency. In comparison, the later-developed 4Y-TZP provides intermediate strength and translucency, while 5Y-TZP has the lowest mechanical strength but the highest translucency. A recent systematic review showed that MZCs made from 3Y-TZP alone demonstrated a clinical survival rate of 91% to 100% over follow-up periods of 0.3 to 2.1 years.[13] However, the studies included in this review were limited by short observation periods.[14–17] Studies with slightly longer follow-ups of up to 5 years have reported technical and biological complications associated with 3Y-TZP-based MZCs.[18–21] Miura et al[18] reported fracture in 2 of 40 MZCs, while Gunge et al[19] reported 1 MZC with biological complications, root fracture and pulpitis, among 148 MZCs. Whether MZCs perform reliably over extended periods such as 10 years remains unclear. Additionally, the authors are unaware of studies comparing the clinical outcomes of MZCs and PFZCs.

This study aimed to assess the cumulative survival and success rates of MZCs and PFZCs retrospectively over a period of up to 10 years and to determine the risk factors for crown and abutment tooth complications. The research hypothesis was that the clinical performance of MZCs would be better than that of PFZCs.

## MATERIAL AND METHODS

A retrospective survey was performed by evaluating the clinical and dental laboratory records of patients who received consecutive MZCs or PFZCs placed on the posterior teeth in the Prosthodontics and Oral implantology Clinics of Fukuoka Dental College Hospital during a 10-year period from April 2011 to March 2021. This study had been approved by the Research Ethics Committee of Fukuoka Dental College (#537). The inclusion criteria were age ≥18 years, regular dental checkups, no high caries activity, and no severe periodontal disease. Periodontal health was assessed using the average probing pocket depth (PPD) and the percentage of bleeding on probing (BOP) values. The presence of ≥5 mm PPD with BOP or the presence of ≥10% BOP was recorded as the presence of periodontitis. Plaque control was evaluated by using the Silness and Löe plaque index (Pl).[22–24] The exclusion criteria were crowns placed on dental implants or on abutment teeth for removable partial dentures, as well as any history of temporomandibular disorders or bruxism, identified based on patient interviews conducted by the attending dentists without the use of specialized assessment tools.

The MZCs required chamfer margins with a 6- to 10-degree taper and an occlusal reduction of 0.5 to 1.0 mm, whereas PFZC abutments required deep chamfer margins with the same 6- to 10-degree taper but a 1.5- to 2.0-mm occlusal reduction.[18,25] A silicone index was used to evaluate the tooth preparation. Three dental technicians (1 from the same institute and 2 from a private dental laboratory) designed and fabricated the crowns. The MZCs were fabricated from ZENOSTAR (Wieland Dental) or CLASSIC (Acucera), and the PFZC copings from KATANA ML (Kuraray Noritake Inc) or KZR-CAD Zirconia T (Kuraray Noritake Inc) (Table 1). The CAD-CAM systems used were GC Aadva (GC), Shofu S-WAVE (SHOFU), or Zeno Tec (Wieland Dental). The crown or coping shape was designed according to a standard protocol. Briefly, the value was set to at least 0.5 mm for coping thickness and 20 to 40 µm for cement layer thickness. All PFZCs were completely veneered with CERABIEN ZR External Stain (Kuraray Noritake Inc), a porcelain material with a thermal expansion coefficient compatible with the coping. After trial fitting and adjustments in the oral cavity, the crowns were returned to the dental laboratory. The PFZCs were sent for staining (CERABIEN ZR External

**Table 1.** Summary of materials used

| Material | Composition (wt%) | Properties | Flexural Strength (MPa) | Manufacturer |
|---|---|---|---|---|
| ZENOSTAR | 94.0% $ZrO_2$<br>6.0% $Y_2O_3$ | 3Y-TZP | 1200 MPa | Wieland Dental |
| CLASSIC | $ZrO_2$ + $Y_2O_3$ + $HfO_2$ + $Al_2O_3$ ≥99.0% | 3Y-TZP | ≥500 MPa | Acucera |
| KATANA Zirconia ML | 94.4% $ZrO_2$<br>5.4% $Y_2O_3$ | 3Y-TZP | 1125 MPa | Kuraray Noritake Dental |
| KZR-CAD Zirconia T | 76.6% $ZrO_2$ + $HfO_2$<br>11.0% $CeO_2$<br>12.4% $Al_2O_3$<br>0.03% $Fe_2O_3$ | 3Y-TZP | 1380 MPa | Yamakin |

Stain; Kuraray Noritake Inc) and glazing, while the MZCs were prepared for final polishing with solid polish (Zircon-Brite; Dental Ventures of America Inc) or for the same staining and glazing procedures. The fabricated crowns were placed using either an adhesive resin cement (Panavia V5; Kuraray Noritake Inc, G-CEM Link Force; GC) or self-adhesive resin cement (SA Routing; Kuraray Noritake Inc). Before placement, the abutment surface was cleaned, and primer (Ceramic Primer; Kuraray Noritake Inc) was applied to the intaglio surface of the crown.

Patient data, including sex, age, number of existing teeth, and lateral occlusion scheme, and crown data, abutment tooth status (vital or nonvital), crown location (maxilla or mandible, molar or premolar, terminal or nonterminal abutment), and type of luting agent used (self-adhesive resin cement or resin cement) were collected by reviewing the clinical record and dental laboratory work authorization. When information was missing, the attending dentists were consulted to provide the necessary details.

Data were statistically compared between the MZC and PFZC groups by using the Mann-Whitney U test or chi-squared test. If the crown and abutment tooth functioned without complications throughout the observation period, the crown was considered a success. If the crown detached from the abutment tooth but could be rebonded, it was assessed as surviving, though not a success. Porcelain chipping was classified as either minor (chipping <2 mm$^2$) or major (chipping ≥2 mm$^2$).[11] Minor chipping that could be managed by polishing was considered survival. Fracture referred to a break in the zirconia coping of the PFZC or in the MZC itself, requiring replacement, and was therefore classified as failure. The examining dentist used a periodontal probe (CP15; Hu-Friedy) to measure the area of the chipping and the thickness of any fractures. If the last day on which the patient visited for maintenance was more than 1 year earlier than March 31, 2021, the last day was considered the end day of follow-up. To analyze crown survival and success, the Kaplan-Meier method was used to create survival and success curves for the MZC and PFZC groups. The log-rank test was then applied to statistically compare these groups.[26] Additionally, a stepwise Cox proportional hazards analysis was conducted to estimate hazard ratios (HRs) and 95% confidence intervals, identifying potential risk factors for crown-related complications (such as crown fracture and debonding) and abutment tooth-related complications (including root fracture, pulpitis, and secondary caries). This analysis was carried out separately for both crown survival and success data. A multilevel survival analysis was performed using StatFlex software version 7.0.11 (Artech Co. Ltd) (α=.05 for all comparisons).

## RESULTS

Based on the previously described criteria, 264 patients who had received a total of 285 crowns were selected for this study. These patients had been treated by 28 dentists, each with a clinical career of at least 3 years. Of the 264 patients with 285 crowns, 29 patients (with 30 crowns) did not return to the clinic after their crowns were placed. As these patients were not included in the follow-up Kaplan-Meier analysis, the study ultimately included 235 participants with 255 crowns (MZC group: 110 participants with 116 crowns; PFZC group: 125 participants with 139 crowns). At baseline, there was a significant between-group difference in the ratio of women to men. No significant between-group differences were noted in the number or ratio of other indices (Table 2). The mean follow-up period was 80 (range, 22 to 120) months (MZC, 75±47 months; PFZC, 82±51 months).

The Kaplan-Meier analysis revealed that the crowns had cumulative survival rates of 95.5% (95%CI, 91.2 to 99.9%) and 76.9% (95%CI, 63.9 to 89.9%) at 5 years for the MZC and PFZC groups, respectively, and 86.0% (95%CI, 72.8 to 99.1%) and 71.0% (95%CI, 54.6 to 87.9%) at 10 years for the MZC and PFZC groups, respectively (Fig. 1). The survival rate was higher in the MZC group than in the PFZC group; however, no

**Table 2.** Baseline characteristics of patients in MZC and PFZC groups

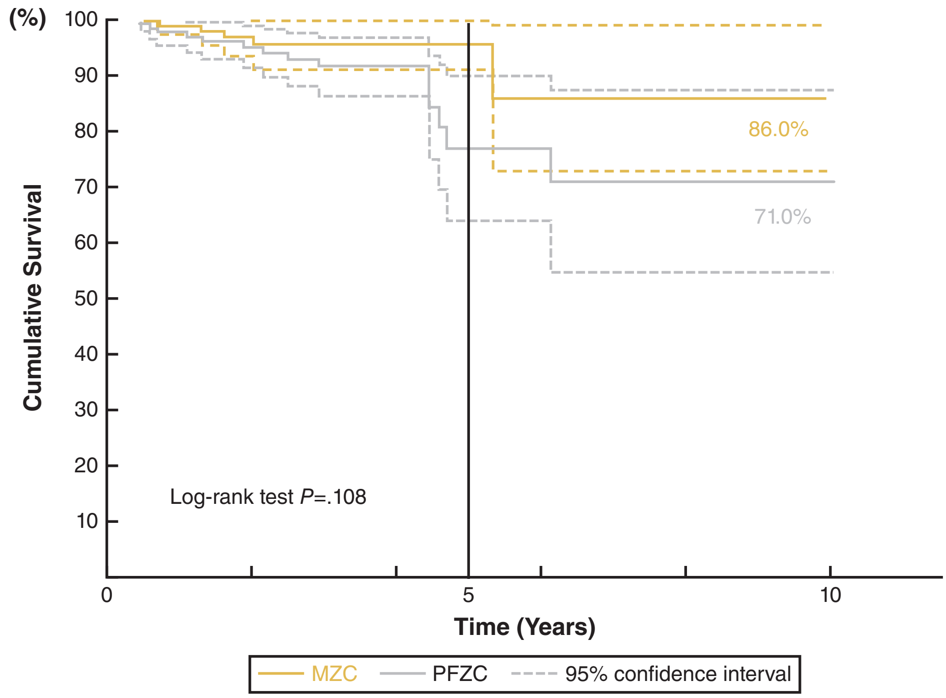
| | MZC (n=116) | PFZC (n=139) | *P* |
|---|---|---|---|
| Sex (Men/Women) | 15/101 | 37/102 | .006[a] |
| Age (years) | 59 ±10.6 | 57 ±17.8 | .852[b] |
| Crown location (Molar/Premolar) | 56/60 | 68/71 | .918[a] |
| Location of crown (Maxilla/Mandible) | 55/61 | 60/79 | .497[a] |
| Location of crown (Terminal/Not terminal dentition) | 49/67 | 48/91 | .206[a] |
| Abutment tooth (Vital/Non-vital) | 45/71 | 42/97 | .150[a] |
| Number of existing teeth (<24/>25) | 43/73 | 53/86 | .861[a] |
| Cement (self-adhesive resin/Resin) | 57/59 | 62/77 | .469[a] |
| Lateral occlusion scheme (Group function/Canine guidance) | 8/108 | 7/132 | .529[a] |

Data expressed as numbers or mean ±standard deviation.

MZC, monolithic zirconia crown; PFZC, porcelain-fused zirconia crown.

[a] : Chi-squared test;

[b] : Mann-Whitney U test.




No. at risk at beginning of each 1-year interval and
no. censored of failed within each 1-year interval

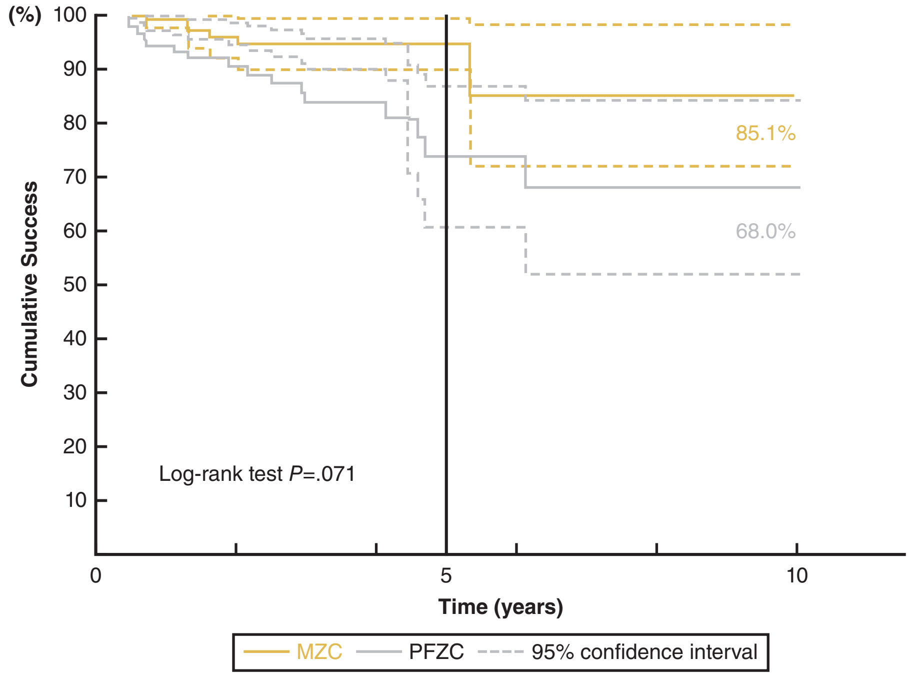
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MZC | | | | | | | | | | | |
| N | 116 | 116 | 108 | 100 | 86 | 70 | 56 | 50 | 46 | 24 | 3 |
| C | 0 | 7 | 8 | 13 | 15 | 13 | 6 | 4 | 22 | 19 | 3 |
| D | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 |
| PFZC | | | | | | | | | | | |
| N | 139 | 139 | 127 | 119 | 93 | 77 | 37 | 22 | 18 | 13 | 8 |
| C | 0 | 9 | 6 | 26 | 13 | 39 | 11 | 3 | 5 | 4 | 8 |
| D | 0 | 3 | 2 | 0 | 3 | 1 | 4 | 1 | 0 | 1 | 0 |

N=number; C=censored; D=failed; interval length=1-year

**Figure 1.** Cumulative survival curves of MZC and PFZC groups. MZC, monolithic zirconia crown; PFZC, porcelain-fused zirconia crown.

statistically significant difference between the 2 groups was found at 5 years (*P*=.107) and 10 years (*P*=.108). The 5-year cumulative success rate was comparable between the 2 groups: 94.6% (95%CI, 89.8 to 99.3%) in the MZC group and 73.6% (95%CI, 60.6 to 86.7%) in the PFZC group (*P*=.099) (Fig. 2). The 10-year cumulative success rate was not significantly higher in the MZC group (85.1%; 95%CI, 72.0 to 98.2%) than in the PFZC group (68.0%; 95%CI, 51.9 to 84.1%), (*P*=.071). Table 3 shows the distribution of each complication factor. A total of 124 crowns were placed on the molars and 131 on the premolars; 115 crowns were placed in the maxilla and 140 in the mandible. Additionally, 119 crowns were placed with self-adhesive resin cements, and 136 crowns with adhesive resin cements. Fifty-four opposing teeth were natural teeth, while 201 were restorations.

Among the 255 crowns examined in this study, 24 (9.4%) developed complications during the follow-up period, with 7 cases in the MZC group and 17 in the PFZC group (Table 4). These complications were categorized as either crown-related or abutment tooth-related. Crown complications included the porcelain chipping of PFZC, fracture of MZC, and debonding. Abutment tooth complications included root fracture, pulpitis, and secondary caries. Crown complications were observed in 15 (5.9%) of the 255 crowns: 3 in the MZC group and 12 in the PFZC group. In the MZC group, no crown frame chipping was observed; however,




No. at risk at beginning of each 1-year interval and
no. censored of failed within each 1-year interval

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MZC | | | | | | | | | | | |
| N | 116 | 116 | 108 | 100 | 86 | 70 | 56 | 50 | 46 | 24 | 3 |
| C | 0 | 7 | 8 | 12 | 15 | 13 | 6 | 4 | 22 | 19 | 3 |
| D | 0 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 2 | 0 |
| PFZC | | | | | | | | | | | |
| N | 139 | 139 | 127 | 119 | 93 | 77 | 37 | 22 | 18 | 13 | 8 |
| C | 0 | 9 | 6 | 26 | 13 | 37 | 11 | 3 | 5 | 4 | 8 |
| D | 0 | 3 | 2 | 0 | 3 | 3 | 4 | 1 | 0 | 1 | 0 |

N=number; C=censored; D=failed; interval length=1-year

**Figure 2.** Cumulative success curves of MZC and PFZC groups. MZC, monolithic zirconia crown; PFZC, porcelain-fused zirconia crown.

2 participants experienced crown fractures requiring replacement with newly fabricated metal crowns (Fig. 3). Additionally, 1 participant experienced debonding, which was resolved by rebonding. In the PFZC group, minor porcelain chipping did not occur, but major porcelain chipping was observed in 10 participants, necessitating the fabrication of new crowns. The zirconia coping remained intact and was not fractured. Additionally, 2 crowns were debonded and subsequently rebonded. Abutment tooth complications were observed in 4 participants in the MZC group and 5 in the PFZ group. In the MZC group, there were 2 root fractures, 1 tooth with pulpitis, and 1 with secondary caries. In the PFZC group, there were 2 root fractures and 3 teeth with secondary caries.

For each survival and success dataset, the Cox proportional hazards analysis was conducted separately for complications in crowns and abutment teeth. In the survival data, no significant findings were observed for either crown or abutment tooth complications (data not shown). However, in the success data, the Cox proportional hazards analysis revealed distinct patterns of significance for crown complications in multivariate analysis (Table 5). No significant differences were found based on crown type (MZC/PFZC; $P$=.274), sex, age, abutment tooth vitality, of the number of existing teeth (<24/>25). However, crown location showed significant differences: molar versus premolar ($P$=.014) and maxilla versus mandible ($P$=.003). This analysis indicated that crowns placed in the molar region (compared with

**Table 3.** Baseline characteristics of patients and their complications

| Category | | Crowns | Complication (%) | |
|---|---|---|---|---|
| | | | No | Yes |
| Sex | Men | 52 (20.4%) | 42 (80.8%) | 10 (19.2%) |
| | Women | 203 (79.6%) | 189 (93.1%) | 14 (6.9%) |
| Age (years) | <64 | 102 (40%) | 91 (89.2%) | 11 (10.8%) |
| | >65 | 153 (60%) | 140 (91.5%) | 13 (8.5%) |
| Location of crown | | | | |
| | Molar | 124 (48.6%) | 109 (87.9%) | 15 (12.1%) |
| | Premolar | 131 (51.4%) | 122 (93.1%) | 9 (6.9%) |
| | Maxilla | 115 (45%) | 98 (85.2%) | 17 (14.8%) |
| | Mandible | 140 (55%) | 133 (95%) | 7 (5%) |
| | Terminal abutment | 97 (38%) | 85 (87.6%) | 12 (12.4%) |
| | Not terminal abutment | 158 (62%) | 146 (92.4%) | 12 (7.6%) |
| Number of existing teeth | <24 | 96 (37.6%) | 82 (85.4%) | 14 (14.6%) |
| | >25 | 159 (62.4%) | 149 (93.7%) | 10 (6.3%) |
| Abutment tooth | Vital | 87 (34.1%) | 78 (89.7%) | 9 (10.3%) |
| | Non-vital | 168 (65.9%) | 153 (91.1%) | 15 (8.9%) |
| Cement | Self-adhesive resin | 119 (46.7%) | 106 (89.1%) | 13 (10.9%) |
| | Resin | 136 (53.3%) | 125 (91.9%) | 11 (8.1%) |
| Lateral occlusion scheme | Group function | 15 (5.9%) | 5 (33.3%) | 10 (66.7%) |
| | Canine guidance | 240 (94.1%) | 226 (94.2%) | 14 (5.8%) |
| Antagonist teeth characteristics | Natural | 54 (21.2%) | 43 (79.6%) | 11 (20.4%) |
| | Restored | 201 (78.8%) | 188 (93.5%) | 13 (6.5%) |

premolars) had a higher risk of complications affecting crown success (HR=6.012), as did those placed in the maxilla rather than the mandible (HR=9.487). In contrast, for abutment tooth complications, the Cox proportional hazards analysis did not identify any significant risk factors (Table 6).

## DISCUSSION

This study found 2 fractures among the 116 MZCs placed, highlighting substantial damage to the more durable zirconia material. However, the 10-year cumulative survival and success rate of MZCs, compared with PFZCs, showed no statistically significant difference, contradicting the research hypothesis that the clinical performance of MZCs would be better than that of PFZCs.

Recent retrospective studies on MZCs have reported a maximum follow-up period of 5 years, showing a 3.5-year survival rate of 91.5%[19] and a 5-year survival rates of 93.1% and 98%, with 5-year success rates of 87% and 94%.[20,21] The 5-year survival and success rates in the present study of 95.5% and 94.5%, respectively, were closely aligned with these previous findings. For PFZCs, a retrospective study with a longer follow-up period reported 10-year survival and success rates of 67.2% and 62.1%, respectively[11]—rates comparable with the 71.0% and 67.9% observed in this study. Overall, the survival and success rates of MZCs and PFZCs in this study were consistent with those of prior research. Metal-ceramic crowns have been estimated to have a 5-year survival rate of 95.7%, according to a systematic review.[10] Additionally, Walton's study[27] on the clinical performance of 2340 high-gold-based metal-ceramic single crowns over up to 25 years reported survival rates of 97.8% at 10 years and 85.4% at 25 years for crowns placed on favorable teeth. Whether MZCs can achieve similarly successful clinical outcomes remains to be determined.

Although the Cox proportional hazards analysis did not identify the type of crown (MZC or PFZC) as a potential risk factor for crown complications, it did identify crown location as significant. Crowns placed on molars rather than premolars and in the maxilla rather than the mandible showed increased risk. This is plausible for molars, which experience greater occlusal force than premolars,[28] but the finding related to maxillary teeth is more challenging to explain. Interestingly, prior studies have reported that tooth loss during periodontal maintenance is more common in the maxilla than in the mandible,[29–31] which may relate to the crown failures observed here.

A post hoc power analysis conducted using a software program (G*power v3.0.10; Heinrich-Heine-Universität Düsseldorf) evaluated whether the sample size (116 crowns in the MZC group and 139 crowns in the PFZC group) was sufficient to detect differences. Using effect sizes of 0.8 (large), 0.5 (medium), and 0.2 (small), the resulting power was 0.99 for a large effect, 0.97 for a medium effect, and 0.35 for a small effect, at a significance level of. 05. These results suggest the sample size was adequate for detecting medium and large effects but underpowered for small effects, a limitation that could be influenced by several biases. For instance, 29 patients, accounting for 30 crowns, dropped out of the study. Since this was a retrospective study without randomization, there was a risk of selection bias. Differences in esthetic and mechanical properties make randomization challenging when choosing between PFZCs and MZCs. In a related prospective study

**Table 4.** All complications in MZC and PFZC groups

| | Pt. (Sex) | Tooth Number | Time to Event (Year) | Material | Crown Related: Porcelain Chipping (Major) | Crown Related: Zirconia Fracture (Major) | Debonding | Abutment Tooth Related: Root Fracture | Pulpitis | Secondary Caries |
|---|---|---|---|---|---|---|---|---|---|---|
| MZC (n=7) | 1 (W) (Fig. 3a) | 37 | 1.2 | CLASSIC | | # (metal crown) | | | | |
| | 2 (W) (Fig. 3b) | 27 | 1.2 | ZENOSTAR | | # (metal crown) | | | | |
| | 3 (W) | 34 | 1.7 | CLASSIC | | | * | | | |
| | 4 (M) | 36 | 1.7 | ZENOSTAR | | | | ** | | |
| | 5 (M) | 27 | 1.3 | ZENOSTAR | | | | ** | | |
| | 6 (W) | 47 | 5.3 | CLASSIC | | | | | # (metal crown) | |
| | 7 (M) | 15 | 1.5 | CLASSIC | | | | | | # (MZC) |
| PFZC (n=17) | 8 (W) | 15 | 3.9 | KZR-CAD | # (MZC) | | | | | |
| | 9 (M) | 36 | 2.7 | KZR-CAD | # (metal crown) | | | | | |
| | 10 (W) | 36 | 2.5 | KZR-CAD | # (MZC) | | | | | |
| | 11 (W) | 25 | 2.7 | KATANA ML | # (metal crown) | | | | | |
| | 12 (M) | 26 | 2.2 | KZR-CAD | # (metal crown) | | | | | |
| | 13 (M) | 27 | 2.3 | KATANA ML | # (MZC) | | | | | |
| | 14 (M) | 26 | 2.7 | KZR-CAD | # (metal crown) | | | | | |
| | 15 (W) | 15 | 1.2 | KATANA ML | # (metal crown) | | | | | |
| | 16 (M) | 26 | 1.4 | KZR-CAD | # (PFZC) | | | | | |
| | 17 (M) | 25 | 6.1 | KATANA ML | # (MZC) | | | | | |
| | 18 (W) | 17 | 6.2 | KATANA ML | | | * | | | |
| | 19 (W) | 27 | 1.5 | KZR-CAD | | | * | | | |
| | 20 (W) | 36 | 1.2 | KZR-CAD | | | | ** | | |
| | 21 (W) | 15 | 1.2 | KZR-CAD | | | | ** | | |
| | 22 (W) | 27 | 0.9 | KATANA ML | | | | | | # (MZC) |
| | 23 (W) | 15 | 4.5 | KATANA ML | | | | | | # (MZC) |
| | 24 (M) | 14 | 1.8 | KATANA ML | | | | | | # (MZC) |
| Total | | | | | 10 | 2 | 3 | 4 | 1 | 4 |

MZC, monolithic zirconia crown; PFZC, porcelain-fused zirconia crown.

#: replaced,

* : rebonded,

** : extracted.

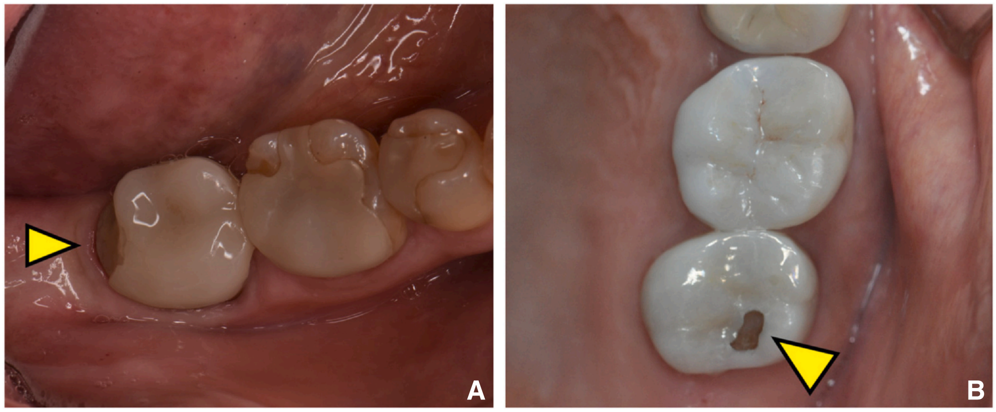



**Figure 3.** Fractures in MZCs. A, On distal quarter of mandibular left second molar. B, On distal portion of occlusal surface of maxillary left second molar.

**Table 5.** Cox proportional hazards analysis of crown complications for success data

| | *P* | HR (95% CI) |
|---|---|---|
| Type of crown (MZC/PFZC) | .274 | 2.167 (0.54 to 8.68) |
| Sex (Men/Women) | .728 | 0.810 (0.24 to 2.66) |
| Age (<64/>65) | .085 | 0.155 (0.01 to 1.29) |
| Abutment tooth (Vital/Non-vital) | .087 | 3.099 (0.84 to 11.33) |
| Number of existing teeth (<24/>25) | .589 | 0.739 (0.24 to 2.21) |
| Crown location (Molar/Premolar) | .014 | 6.012 (1.42 to 25.37) |
| Crown location (Maxilla/Mandible) | .003 | 9.487 (2.09 to 42.89) |

HR, hazard ratio; 95% CI, 95% confidence interval.

**Table 6.** Cox proportional hazards analysis of abutment tooth complications for success data

| | *P* | HR (95% CI) |
|---|---|---|
| Type of crown (MZC/PFZC) | .820 | 0.836 (0.17 to 3.90) |
| Sex (Men/Women) | .060 | 0.226 (0.04 to 1.06) |
| Age (<64/>65) | .332 | 2.091 (0.47 to 9.30) |
| Abutment tooth (Vital/Non-vital) | .287 | 0.478 (0.12 to 1.86) |
| Number of existing teeth (<24/>25) | .747 | 0.775 (0.16 to 3.64) |
| Crown location (Molar/Premolar) | .355 | 2.945 (0.29 to 29.18) |
| Crown location (Maxilla/Mandible) | .185 | 5.330 (0.44 to 63.35) |

HR, hazard ratio; 95% CI, 95% confidence interval.

on the 5-year clinical performance of MZCs and PFZCs,[20] most MZCs (96.5%) were used on posterior teeth, whereas PFZCs (62.5%) were primarily placed on anterior teeth. A similar distribution may have occurred here, as MZCs were more frequently selected for patients with higher occlusal force on the subjective judgment of the treating dentists. Information bias also influenced this study, as data were limited to clinical charts and dental laboratory work prescriptions.

This study found that the 10-year cumulative success rate was not significantly higher in the MZC group (85.1%) than in the PFZC group (68.0%) ($P$=.071). The minimum occlusal thickness of 0.5 mm for MZCs may have contributed to this outcome. All participating dentists aimed for an occlusal reduction of 0.5 to 1.0 mm for MZCs, but they did not verify the thickness at crown placement. Nevertheless, 2 of 116 MZCs fractured at an occlusal thickness of 0.5 mm. These fractures occurred on the second molar teeth, which are challenging to reduce adequately[32,33] and are subject to high occlusal loads (Fig. 3).[28] While laboratory studies recommend a minimum occlusal thickness of 0.5 mm,[34,35] clinical findings suggest that a thickness of 1.0 mm or more may be preferable for patients with high occlusal loads.

## CONCLUSIONS

Based on the findings of this retrospective clinical study, the following conclusions were drawn:

1. The MZC group had statistically similar survival and success rates compared with the PFZC group.
2. Crowns placed on molars rather than premolars and on the maxilla rather than the mandible were associated with an increased risk of crown failure but not of abutment tooth failure.

3. The results may have been influenced by selection biases, such as patient dropout, crown type selection, and the retrospective, nonrandomized study design.
4. Additional information biases could arise from the limited data available in clinical charts and dental laboratory prescriptions.
5. The clinical application of a 0.5-mm MZC occlusal thickness based on the laboratory findings may also have had an impact.

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