ORIGINAL ARTICLE

Frequency of Porcelain Fracture in Patients with Bruxism Reporting to the Department of Prosthodontics Bacha Khan College of Dentistry

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Abstract

Background: Bruxism increases the risk of mechanical complications in porcelain-based restorations, potentially affecting their longevity.

Objectives: To determine the prevalence and associated factors of porcelain fracture among bruxism patients presenting to the Department of Prosthodontics, Bacha Khan College of Dentistry, Mardan.

Materials and Methods: This six-month cross-sectional study included 154 patients aged 18–60 years diagnosed with bruxism who had porcelain-based restorations placed at least three months prior. Bruxism was diagnosed based on self-reported morning jaw pain (VAS > 3), morning headaches (VAS > 3), and pain/discomfort during chewing, in accordance with symptom-based criteria used in clinical cross-sectional research in resource-limited settings. Clinical examination assessed the presence, location, and severity of porcelain fractures. Data were analyzed using SPSS version 27. Chi-square and logistic regression tests evaluated associations between incidence of fracture and type of bruxism, restoration type, restoration age, and gender ($p \leq 0.05$).

Results: The prevalence of porcelain fracture was 63.6% (98/154). Fractures occurred exclusively in metal-ceramic crowns, where the within-group fracture rate was 96.1% (98/102) ($p < 0.001$). Nocturnal bruxism and restorations older than five years were significantly associated with fractures ($p < 0.001$; $p < 0.01$). Gender showed no significant association (OR = 0.67; 95% CI: 0.346–1.296; $p = 0.234$). Most fractures involved posterior teeth (79.6%), with over half requiring replacement.

Conclusion: Porcelain fractures were observed exclusively in metal-ceramic crowns among bruxism patients in this single -center cross-sectional study. Nocturnal bruxism and restoration age exceeding five years were significantly associated with fracture occurrence

Keywords: *Dental Porcelain, Tooth Fractures, Bruxism, Dental Restoration Failure, Prosthodontics, Metal-Ceramic Alloys*

Introduction

Porcelain, especially feldspathic ceramics, is used in dentistry for its excellent aesthetics, biocompatibility, and conservative nature. It provides predictable results in restoring tooth color, shape, and alignment, even in cases of wear or erosion.[1] Despite their durability, porcelain restorations may fail under clinical conditions due to occlusal stress.[2]

Research has shown that metal-ceramic crowns can experience porcelain fractures at approximately 15% over a 10-year period.[3] Porcelain fractures are a significant issue for both patients and dentists, resulting in considerable costs.[4] In the anterior region, fractures primarily affect aesthetics, while in the posterior region, they can also impact chewing function. The mismatch in modulus between metal and ceramic materials can lead to mechanical failures in metal-ceramic restorations.[5] Clinical failures may occur due to a range of issues, including inappropriate metal coping design, excessive porcelain thickness, inadequate preparation of the abutment teeth, insufficient space for the restoration, technical errors, contamination, trauma, and parafunctional movements such as bruxism.[6]

According to the American Academy of Sleep Medicine, bruxism can be defined as the repetitive muscle activity of the jaw characterized by clenching or grinding of teeth and/or bracing or thrusting of the mandible.[7] Bruxism is characterized by forceful grinding between the upper and lower teeth. There are two types: awake bruxism, which occurs during the day, and sleep bruxism, which happens at night.[8] Fractured porcelain is a common complication seen in individuals who grind their teeth due to bruxism.[9] Patients with bruxism exerts heavy forces which can affect teeth and dental restorations, leading to an increased risk of porcelain fractures[8].Bruxism subjects dental restorations, particularly porcelain crowns and veneers, to high levels of stress and fatigue. The clenching and grinding movements are repetitive and therefore the microcracks may form in the porcelain material, which will ultimately result in breaking down.[9]

There are two types of Bruxism, primary, which is not related to any other medical condition, and secondary, which is connected to such issues as neurological problems or side effects of medications.[9,10] The suggested approach towards dealing with bruxism consists of three key angles. Wearing of an occlusal splint especially that of the hard acrylic resin is an effective method of protecting the teeth against damage.[11] In addition to the increase of patient awareness regarding their habits, the education of techniques of relaxation, the encouragement of healthy lifestyle and sleeping habits, the medication is included only in the most severe cases, when other techniques are not effective.[12]

Fracture of porcelain among patients with bruxism is a severe issue due to the mechanical forces of recurrent automatic grinding and clenching of teeth. Despite growing evidence on bruxism-related restorative complications, limited data exist from developing-country clinical settings on fracture frequency specifically across different porcelain restoration types in a bruxism-diagnosed population. This study addresses that gap. Data regarding the rate of these fractures will be valuable while taking the preventive measures for these materials and restorative methods, to enhance the quality and durability of dental

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prostheses among patients with bruxism. This knowledge can inform treatment planning and patient education, potentially contributing to better outcomes and reduced need for repair or replacement. We hypothesized that patients with nocturnal bruxism and older metal-ceramic restorations would exhibit higher rates of porcelain fracture compared to those with awake bruxism or newer restorations. This study will also set out to define porcelain fractures in patients with bruxism who presented to the department of Prosthodontics Bacha Khan College of Dentistry ,Mardan.

Material and Methods

This cross-sectional research was conducted in Department of department of Prosthodontics, Bacha Khan College of Dentistry, Mardan, over the period of 6 months from February 25, 2023 to August 25, 2023 after approval from the College of Physicians and Surgeons Pakistan (CPSP) Research Evaluation Unit with reference number **CPSP/REU/DSG-2022-028-4201**.A total of 154 participants were enrolled, with the sample size calculated using WHO sample size software, considering a 95% confidence interval, 7% margin of error, and an expected porcelain fracture frequency of 26.7% among bruxism patients 15. Bruxism was diagnosed using symptom-based clinical criteria (morning jaw pain VAS > 3, morning headaches VAS > 3, pain/discomfort on chewing). Awake bruxism was differentiated by the absence of nocturnal symptoms and presence of daytime clenching reported by the patient. Minor chips were defined as surface enamel/porcelain loss not extending to the dentine and not requiring full restoration replacement. Major fractures were defined as porcelain loss exposing the underlying metal framework or dentine, necessitating restoration replacement.

Participants were chosen using a consecutive sampling method, where every eligible individual was included in the study. The inclusion criteria included patients of both genders, aged 18-60, with porcelain dental restorations (crowns, veneers, or complete restorations) that had been placed at least three months prior to the study. In addition, patients with morning jaw pain Visual Analogue Score (VAS > 3), headaches in the morning (VAS > 3), and pain/discomfort during chewing or biting were included in the study. Those patients who had undergone facial trauma, orthodontics, jaw surgery, or radiotherapy of the head and neck could not take part in the study.

The study was conducted upon the qualified individuals who were enlisted after obtaining the consent of both the institutional ethics committee, and the College of Physicians and Surgeons Pakistan (CPSP). All the participants gave written informed consent to participate in the study
after being fully informed about the objectives of the research and the possible benefits.

Information about demographic factors, such as age, gender, BMI, education, type and period of dental restoration, residential, smoking, and socioeconomic status were collected.

A quality clinical assessment was conducted to investigate the porcelain restorations in respect of cracks, chips or fractures and the extent, place (anterior or posterior place) and severity of fractures were noted based on the predetermined operational descriptions. Single examiner was used to ensure there was less inter examiner bias.

The analysis of data was performed with SPSS 27. Categorical variables were given in the form of frequencies and percentages including gender, level of education, type of restoration, socioeconomic status, type of bruxism, smoking status and the presence of porcelain fracture. The quantitative variables such as age and duration of restoration were represented in the form of mean +- standard deviation of normally distributed data and median with interquartile range of non-normally distributed data, which was determined by the Shapiro-Wilk test. The Chi-square (χ^2) test was employed to compare the rate of fractures of porcelain in the various categories i.e. type of bruxism (nocturnal and awake), the type of restoration (metal-ceramic, veneers and full- porcelain) and the demographic variables (gender and socioeconomic status) with a Fisher exact test when the cells were smaller than five in number. The independent predictors of porcelain fractures were estimated by multivariable logistic regression, whereby, the dependent variables were adjusted by such factors as gender, the age of the restoration, and the type of bruxism
which might affect the result. The results were reported using odds ratios (ORs) with 95% confidence intervals (CIs) and the variables that were considered to have a significant association ($p \leq 0.05$) during the univariate analysis were put in the final model. The age of restoration (less
than 1 year, 1-5 years, more than 5 years), location of the tooth (anterior and posterior), and severity of the fracture (minor chips and major fractures) were used to further classify fracture rates and examine possible relationships and trends.

Results

This is a study that assessed the rate of porcelain fractures in 154 patients with bruxism who had dental restorations composed of porcelain. The results obtained were important, presenting the evidence on prevalence, factors, and clinical trends of fractures. A total of 154 participants out of which 84 were males (54.5%) and 70 were females (45.5%) having mean age 44.7 ± 7.36 years. The analysis of age distribution showed that most of the participants were in the age (41-50 years) of 42.2.% (n=65), under 40 years old (31.16% n=48) and above 51-60 years in the age range (26.62% n=41). Assessment of socioeconomic status revealed that two-thirds (74.0%, n=114) individuals were in the middle/high income groups, and one-third (26.0%, n=40) of the individuals were in the low socioeconomic status. Concerning the type of bruxism, nocturnal bruxism (79.2% n=122) was a lot more common than awake bruxism (20.8% n=32). Table 1 provides the entire demographic

Variables	Frequency	Percentage	Total
Gender			
Male	84	54.5%	
Female	70	45.5%	154
Socioeconomic status			
Low	40	26.0%	
Middle/High	102	74.0%	154
Age (Years)			
< 40	48	31.17%	
41-50	65	42.21%	
51-60	41	26.62%	
Type Of Bruxism			
Nocturnal bruxism	122	79.2%	
Awake bruxism	32	20.8%	154

Table 1: Demographic Characteristics of Participants

This table presents the baseline demographic profile of the 154 study participants, including their distribution by gender, socioeconomic status, age, and type of bruxism. This table shows that participants were predominantly male (54.5%), from a middle/high socioeconomic background (74.0%), and most fell within the 41-50 age range. Crucially, the vast majority (79.2%) were diagnosed with noc-

turnal bruxism, which the study later identifies as a major risk factor.

profile.

This research shows that majority of participants presented with bruxism had metal-ceramic crowns102 (66.2%), followed by veneers 32(20.8%) and full-porcelain restorations 20(13.0%) as shown in Figure 1.

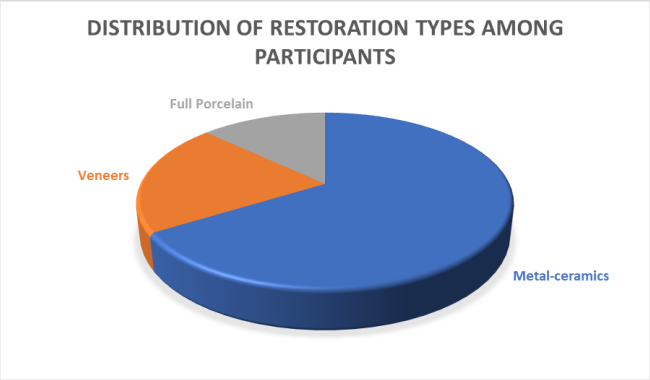

Figure 1: Distribution of restoration types among participants

This graph illustrates the prevalence of different types of porcelain restorations present in the study population. Metal-ceramic crowns were by far the most common restoration type (66.2%), followed by veneers (20.8%) and full-porcelain crowns (13.0%). This distribution is important context for interpreting the fracture rates by type.

The overall prevalence of porcelain fracture was 63.6% (98/154) across the entire study sample. All 98 fractures occurred exclusively in metal-ceramic restorations; consequently, the within-group fracture incidence for metal-ceramic crowns was 96.1% (98/102). No fractures were recorded in veneers (0/32) or full-porcelain restorations (0/20) ($p<0.001$). Nocturnal bruxism was associated with an 80.3% (98/122) fracture rate compared to 0% in the awake bruxism group ($p<0.001$). Within-group fracture rates rose with restoration age: 0.0% for <1 year (0/24), 60.9% for 1–5 years (39/64), and 89.4% for >5 years (59/66) ($p<0.001$) are presented in Figure 2. This confirms restoration age as a significant predictor of fracture. Table 2 provides the complete analysis.

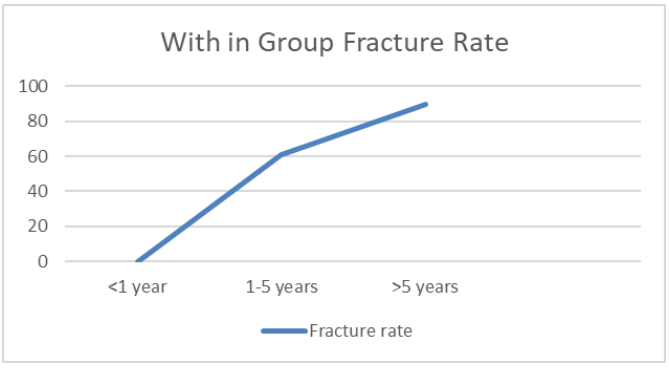

Figure 2: Trend of porcelain fractures within group by restoration age).

This figure 2 shows within-group fracture rates according to age of restoration: 0.0% for restorations <1 year, 60.9% for 1–5 years, and 89.4% for >5 years. This graphically emphasizes that restoration age is a significant predictor of fracture.

Table 2: Porcelain fracture rates by clinical and demographic factors (n=154)

Factor	Category	Fracture Rate (%)	p-value
Overall	-	63.6	
Restoration type	Metal-ceramic	96.1	<0.001
	Veneers	0	
	Full-porcelain	0	
Bruxism type	Nocturnal	80.3	<0.001
	Awake	0	-
Restoration age	<1 year	0	<0.001
	1-5 years	60.9	-
	>5 years	89.4	-
Gender	Male	67.9	0.153
	Female	58.6	-

This table is based on the comparison of incidences (percent) of porcelain fractures in different categories of patients and restorations and the p-values to indicate the statistical significance. The overall fracture prevalence was 63.6% (98/154). The within-group fracture rate was highest in metal-ceramic crowns at 96.1% (98/102), while veneers and full-porcelain restorations showed 0% fracture rates. The rate of fracture in nocturnal bruxism was 80.3% compared to 0% in awake bruxism ($p<0.001$). The rate of fracture rose with the age of the restoration. Although, males were more likely to experience fracture (67.9%) when compared to females (58.6%), this was not statistically significant ($p=0.153$).

The univariate logistic regression analyses were done to test the association between individual predictor variables and the occurrence of porcelain fracture. Nonetheless, the circumstances of zero cells in the contingency tables of the bruxism type, restoration type and restoration age meant that the standard logistic regression could not be carried out on these variables. Gender analysis was the only parameter that could be estimated.

Given the categorical distribution of these variables, Firth penalized likelihood logistic regression would be more appropriate for future studies to handle complete separation. In this study, we report the chi-square associations and acknowledge that odds ratios for these variables could not be estimated by standard maximum likelihood.

A one variable logistic regression model was conducted on gender as the only predictor of porcelain fracture. All 154 respondents (84 males, 70 females) were incorporated in the model where female was used as reference category. The findings showed that male patients had 33.0% lower odds of porcelain fracture than female patients (Odds Ratio [OR] = 0.670, 95% Confidence Interval [CI]: 0.346 to 1.296, Wald 2 = 1.417, p = 0.234). The 95 percent interval intersected with 1.0 which further confirmed that no statistically significant association was found between gender and fracture. The constant value was also not negligible (B = 1.148, p = 0.029), so the baseline odds of fracture were 3.152 in case of females. Table 4 gives the entire results.

For bruxism type, restoration type, and restoration age, standard logistic regression could not be performed due to the presence of zero cells in the contingency tables

Table 4: Univariate Logistic Regression Analysis for Gender

Variable	B	S.E.	Wald	df	p-value	OR	95% CI
Gender (Male)	-0.401	0.337	1.417	1	0.234	0.670	0.346 – 1.296
Constant	1.148	0.526	4.756	1	0.029	3.152	

Gender coded as 1=Male, 2=Female; Female is reference category

(complete separation). As shown in Table 2, no fractures were observed in the awake bruxism group, in veneers or full-porcelain restorations, or in restorations less than 1 year old. This perfect prediction precludes the calculation of meaningful odds ratios using standard maximum likelihood estimation.

Analysis of fracture patterns revealed notable clinical characteristics. Posterior teeth were more affected by fractures (79.6%) compared to anterior teeth (20.4%), reflecting greater occlusal forces in posterior regions; no statistically significant association was found (p=0.26). In terms of severity, minor chips (45.9%) and major fractures (54.1%) occurred at comparable frequencies, with major fractures slightly predominating, indicating a high clinical burden. These fracture characteristics are detailed in Table 5.

Table 5: Clinical characteristics of porcelain fractures (n=98)

Characteristic	n/ total fracture (%)	P-value
Location: Posterior teeth	78/98(79.59%)	0.26
Location: Anterior teeth	20/98(20.41%)	_
Severity: Minor chips	45/98(45.92%)	0.54
Severity: Major fractures	53/98(54.08%)	_

*This table details the patterns of the 98 fractures that occurred, specifically their location in the mouth and their severity. Nearly two-thirds of fractures (79.59%) occurred in **posterior teeth** (molars and premolars), which bear the greatest chewing forces. The fractures were almost evenly split between **minor chips** (45.92%) that might be repaired and **major fractures** (54.08%) that likely required full replacement of the restoration, indicating a high clinical impact.*

Discussion

The study under consideration investigated the rates of porcelain fracture in 154 patients having bruxism who had dental restorations composed of porcelain. The overall prevalence of fracture was 63.6% (98/154). All 98 fractures occurred exclusively in metal-ceramic crowns, yielding a within-group fracture incidence of 96.1% (98/102), while both veneers and full-porcelain restorations showed 0% fracture rates.

The cause of this difference might be in the inherent material behaviour whereby metal-ceramic interfaces tend to delaminate or chip more easily during parafunctional loading with the monolithic or full-porcelain design redistributing the stress load more uniformly. A retrospective study performed on implant-supported metal-ceramic restorations involving porcelain fracture of the type had been observed to have been 9.4 percentage of units which was considerably associated with bruxism. Likewise, higher odds of porcelain fracture (OR=7.23) were also observed in bruxers not wearing occlusal appliances in this study, which confirms the vulnerability of metal-ceramic restorations[13] but full-porcelain restorations in our study were more resilient, as was found in studies conducted on lithium disilicate crowns, which showed exceeding 98% survival rate over 11 years in bruxers due to improved fracture toughness. These comparisons imply that within-group fracture rate of 96.1% (98/102) was most common in patients having metal-ceramic crowns and, nevertheless, clinicians should prefer monolithic ceramics in bruxism patients in order to reduce the risk of fracture, and our zero fracture rate in full-porcelain restorations is possibly reflective of its superiority in high-load situations.[14,15]

Nocturnal bruxism had significantly higher fracture rates (63.6) than awake bruxism (0%), and were statistically significant (p<0.001). Such a finding indicates that nocturnal bruxism is a major risk factor, probably because of uncontrolled and severe muscular activity during sleep producing forces up to several times greater than normal level of mastication. And previous studies support this; such as a systematic review found sleep bruxism to be associated with more technical complications in implant-supported prostheses, such as porcelain fractures.[16] but awake bruxism, which is more stress-induced and often more intermittent, may result in less cumulative damage as shown by the lower rates of failures in our study. A meta-analysis further found that sleep bruxism was linked to ceramic failures with odds ratios of chipping and fracture being higher in nocturnal cases.[17]The absence of fracture in awake bruxism patients may be due to less force being applied or better patient awareness resulting in protective behaviors but our results highlight the need to target interventions such as occlusal splints at nocturnal bruxers to alleviate nocturnal overload.[9,18]

Age of restoration was also a significant predictor of fracture having within-group rates range from 0.0% (<1 year) to 60.9% (1–5 years) and 89.4% (>5 years; p<0.001). This gradual rise is probably as a result of the accumulation of fatigue, as constant cyclic loading during bruxism causes the weakening of porcelain with time. A 8-year retrospective of porcelain veneers indicated a decrease in survival rate ranging from 93.5% at 10 years to only 78.5% at 20 years, suggesting declines to age related veneer[19].Other long-term analyses of all-ceramic restorations found survival of 93.5 percent at 10 years and 78.5 percent at 20 years, and attributed fractures to prolonged exposure in parafunctional individuals.[20] Our research indicates that a faster increase in fracture after 5 years is possibly caused by increased degradation amongst patients with bruxism, which means that restorations may require closer observation and possible replacement after this period of time, are necessary to avoid disastrous failure.

There were also higher fracture rates in males (67.9%) compared to females (58.6%), but they were not statistically significant (p=0.153). Univariate logistic regression analysis has shown that males had 33% lower odds of fracture (OR=.670) with the confidence interval exceeding 1, showing no significance. Nevertheless, a bite force study detected no gender difference in maximum force which is consistent with our non-significant findings and indicates that there may be no significant difference between sexes regarding the magnitude of force in patients with bruxism. This minor male preponderance of fracture may be associated with increased bite forces or unrecorded parafunctional intensity, but in general, gender does not have such a significant effect on the number of fractures as bruxism type or age of restorations.[21]

The fracture patterns were found to involve (79.6) fracture in the posterior teeth, which is in line with the fact that

there were more forces on the occlusal surfaces of the molars and premolars during bruxism. This is similar to the results of a study on zirconia restorations, in which 79% of the fractures were in the posterior teeth because of load-bearing stress. Fracture severity was almost as high in minor fractures (45.9) and major fractures (54.1), implying high clinical load as major fracture may require replacement.[22] Similar outcomes were found with comparative data from a study conducted on endo-crown evaluation, with bruxism increasing the overall severity. These patterns indicated that the presence of bruxism increased stress on posterior teeth, which demands for the need to use a restoration made of reinforced materials or occlusal guards in the high-risk zones.[23]

The findings of this paper demonstrate the necessity to screen bruxism during the restorative planning with the preference of durable materials such as full-porcelain in the case with nocturnal cases of bruxism and stress on the value of protection of occlusal protection by using occlusal splints. This study has several limitations. The cross-sectional design precludes causal inference, and bruxism diagnosis relied on symptom-based clinical criteria rather than objective tools such as polysomnography or EMG, introducing potential misclassification bias. Being a single-Centre study with restorations fabricated at one in-house laboratory, generalizability is limited and laboratory quality cannot be excluded as a contributing factor to the high fracture rate observed in metal-ceramic crowns. Key prosthodontic determinants including porcelain thickness, coping design, cement type, cantilever configuration, and opposing dentition type were not recorded, representing uncontrolled confounding. Occlusal splint use and parafunctional severity were similarly not captured. The zero-cell complete separation precluded standard logistic regression for most variables; Firth penalized likelihood regression is recommended for future studies with similar data structures, and the absence of fractures in awake bruxism, veneer, and full-porcelain subgroups should be interpreted cautiously given their small sample sizes rather than as evidence of absolute protection. Future research should employ longitudinal multicenter designs with polysomnography-confirmed bruxism, systematic recording of prosthodontic variables, and comparative evaluation of restoration types using standardized laboratory protocols to provide stronger evidence for material selection in high-risk bruxism patients.

Conclusion

The high occurrence of porcelain fractures was experienced on the patients with bruxism, and fractures were only seen in the metal-ceramic crowns. Bruxism at night and higher age of restoration were significantly correlated with higher rates of fracture and there was no gender association. Posterior teeth were more commonly fractured and had to undergo restoration replacement. Due to the study design, no causal inference can be drawn. Zero-cell complete separation precluded logistic regression analysis for most variables. These findings should be interpreted within these methodological constraints and validated through longitudinal multicenter studies.

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Author Contributions

1. **Sajid Ali:** Conceptualization of the study, study design, and manuscript drafting.
2. **Momena Mumtaz:** Data collection and manuscript drafting.
3. **Naila:** Data analysis and interpretation of results.
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