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Failure Rate of Porcelain-Fused-to-Metal (PFM) Crowns in Taiz, Yemen: A Cross-Sectional Analysis

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ABSTRACT

Objectives: This study aimed to determine the causes of failure in porcelain-fused-to-metal (PFM) dental crowns in Taiz Governorate, Yemen.

Methods: The research employed a descriptive cross-sectional analysis recruited about 40 participants using a questionnaire which distributed to dentists and dental technicians.

Results: Most (70%) of the participants were male and 50% had a bachelor's degree. Experience levels ranged from 5.0 to 47.5 years; those with more than 5 years of practice accounted for 52.5%. The most frequently reported causes of crown failure were tooth preparation inappropriate to the crown (100%), unclear abutment line (100%), misfit crowns (90%), neglect of oral hygiene (70%) and gum infection (57.5%). Crown longevity could be predicted by psychological factors (75%) and material quality (100%). Furthermore, failure was estimated to be due from inadequate sealing and poor adhesive cement in 90%. Also meriting mention is that 75% agreed that not the patient, but rather lack of proper installation and high-quality adhesive cement, were responsible for failure. Additionally, the study highlighted that dentists and technicians were equally responsible for shared causes of common failure, as indicated by all of the participants (100%).

Conclusion: The results of the study indicate that PFM crown failure is the outcome of a multifactorial process and therefore is closely dependent on the correct clinical procedure, the chosen material and cooperation between the dental professionals. Addresses to these factors might improve the long-term success of PFM restorations.

Keywords: Porcelain-fused-to-metal (PFM) Crowns, Dental Crown Failure, Tooth Preparation, Dental Technicians, Taiz Governorate.

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INTRODUCTION

Losing teeth greatly affects a person's appearance and spurs a loss in self-esteem [1]. However, since dentistry has become more and more advanced, we are able to have very effective treatments for tooth loss. One of the most successful procedures of restoring missing teeth and surrounding tissues is for the dental prostheses and implants [2]. Porcelain fused to metal (PFM) dental crown is one of the valuable restorations used in both cosmetic as well as restorative dentistry [3]. This is because PFM crowns can combine the beauty of the porcelain and the strength and precision of a metal crown [4]. One example of a PFM crown chosen in dentistry is a durable and functional [5]. However, the success of these restorations is very much dependent on careful preparation, especially of adequate thickness of the metal and porcelain layers. If this process for preparation is incorrect, can lead to theming the problem such as poor shape or oversized restorations that will effect on aesthetically or periodontally and metal or opaque material knock out under the low layer of the porcelain creating mismatches and visual distress. [6]

There exist a number of studies on crowns and bridges on oral tissue (marginal fit, composition, surface roughness and replies on periodontium). If crowns or bridges are not the proper fit on your teeth, it can cause an infection of your gums, recession and eventual loss of the bone which is a roll up to the failure of the tooth [7]. PFM crown has survival rate of 92.3%-95.9%, which is very high, but failure occurs due to poor preparation and fit [8]. Iatrogenic factors, laboratory faults, material properties and trauma may be responsible for the fractures within ceramic fused to metal restorations [9]. Other studies have reported a 78% 20-year survival with PFM crowns. This makes the success of these crowns' dependent on properly applied technique as well as the choice of Che et al .[10],.

Importance of this study to science lies in that it helps to identify the common errors of dental practitioners and technicians failing the PFM crowns. This will improve knowledge regarding porcelain fused to metal crowns and attempt to resolve their failures. The study helps dental practitioners and dental technicians achieve their experience and insight about the PFM crowns fabrication so as to assist in hand on fabrication of the crowns. The study is also aimed at ascertaining the other failure rate that is the umbrella failure rate of the crown and the factors of failure due to dentist and dental technician, with the solution and correction. In addition, the study is aimed at educating dental students and practitioners of appropriate techniques to fabricate high quality PFM crowns and to increase recognition of common causes of failure.

METHODS

Study Approach

A descriptive cross-sectional method was used in this study, and it was from March 6, 2024 to December 2, 2024, whereby data was collected in various dental clinics and laboratories in Taiz city, Yemen for the current study. The study was selected to be conducted in Taiz because it is a place having a comprehensive dental practice environment and PFM restorations is a huge percentage of the patients here. This gave this study period enough time to be able to collect, analyze and interpret the necessary data so as to cover all the cases within the city's dental facilities.

Study Population

This study targeted the population of those being treated with permanent form dental crowns, dentists, and dental techs. Students, dental technicians and dentists were recruited as they are selected based on their practical experience and expertise in prosthetic restorations with patients diagnosed as having PFM crown failure included to allow clinical evidence of failure causes. A diverse approach was taken with this sample to allow for an extensive data collection on both technical and clinical aspects of PFM crown failure.

Study Sample

For data representative, objective collection, a simple random probability sampling method was used. Forty dentists and dental technicians were interviewed and the factors contributing to crown failure were assessed in light of the opinions gathered through a structured questionnaire. The sample was widely ranging cases, which allowed meaningful analytical and conclusions based on statistical analysis.

Study Tools

To collect the necessary data, the researchers utilized a structured questionnaires consisting of 19 questions was derived from previous studies and modified by the



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authors to gather insights from dentists and dental technicians regarding their experiences with PFM crown failures. The questionnaire was reviewed and validated by a committee of dental specialists to ensure its accuracy and relevance. Based on expert feedback, the questionnaire was refined before being finalized for use in the study. To facilitate the researchers' work, an official memorandum from the College Dean was issued to encourage dentists and technicians to participate in the study.

Questionnaires included three major area such as demographics e.g (age, gender, academic qualifications and years of experiences) and 8 items about factors contributing to dental crown failure, lack of clear abutment lines, misfit crowns, neglect of oral hygiene, and gum infections. Third area included items about psychological factors and the quality of materials.

Data Collection Procedure

Data was collected through structured interviews and surveys from dentists as well as dental technicians, and from the professional point of view in order to find out the most common causes of PFM crown failure. The provided value of these professionals who gave a great perspective and advice about material selection, fabrication processes, and how common errors end in a restoration failure.

Ethical Approval

The study was approved with ethical considerations using the number MEC AD064 by the University of Science and Technology, Aden, Yemen. All steps of the research process were carried out in an ethical way. All patients, dentists and technicians were informed about the study's objectives before participation and obtained written informed consent from each participant. All patient record and survey response were maintained confidentially and hence the identity of the participants remained protected. In addition, the study also followed the international and national guidelines for the research conducted in the field of clinical dentistry that no harm or discomfort was caused to the participants while carrying out the study.

Data Analysis

The collected data were analyzed using SPSS version 23 and excel sheet to identify the prevalence and any trends or relationships between variables. PIDI was employed to summarize key findings regarding the causes and frequency of PFM crown failure through descriptive statistics, such as frequencies, percentages, and means.

Key Terminology

- *Porcelain-Fused-to-Metal (PFM) Crowns:* Dental restorations consisting of a metal substructure for strength and durability, covered with a porcelain layer for an aesthetic and natural appearance.
- *Failure of PFM Crowns:* The occurrence of complications or defects leading to the functional or aesthetic failure of PFM restorations.

RESULTS

Demographic Data Analysis

The demographic analysis reveals that the majority of study participants are male (70%), while females make up 30%. Regarding academic qualifications, half of the participants (50%) hold a bachelor's degree, followed by diploma holders (40%). Only 5% have expertise-level education or a master's degree. In terms of experience, slightly more than half (52.5%) have more than 5 years of experience, while 47.5% have less than 5 years.

Variable	Category	Frequency	Percentage	
Gender	Male	28	70%	
	Female	12	30%	
Academic Qualification	Expertise	2	5%	
	Diploma	16	40%	
	Bachelor's	20	50%	
	Master's	2	5%	
Years of Experience	Less than 5 Years	19	47.5%	
	More than 5 Vears	21	52 50%	

Table 1. Demoscoubie englacian 40



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Table 2 revealed that the main factors contributing to dental crown failure include poor tooth preparation and lack of clear abutment lines (100%), followed by

misfit crowns (90%). Other significant causes include neglect of oral hygiene (70%) and gum infections (57.5%).

Cause of Failure	Repetition	Percentage
Poor tooth preparation & unclear abutment lines	40	100%
Missing crown edges or poor fit on the dental abutment	36	90%
Lack of oral hygiene and failure to review periodically	28	70%
Gum diseases and infections	23	57.5%
Poor material quality in dental crowns	19	47.5%
Failure to sand metal or poor sanding process	17	42.5%
Incorrect impression leading to poor abutment details	16	40%
Poor quality of adhesive cement	12	30%

Table 3 indicated that psychological factors (75%) and the quality of materials (100%) are considered the most critical factors for the success of dental crowns. A strong consensus (90%) supports the idea that poor sealing of edges and inadequate adhesive contribute significantly cement to crown deterioration. Additionally, the majority of respondents (75%) believe that crown failure is not caused by the patient, while 80% agree that proper crown installation and the use of high-quality adhesive cement are essential for long-term success. Furthermore, the role of both the dentist and the dental technician is seen as crucial, with 100% of respondents agreeing that common failure causes exist between them.

Question	Yes	Maybe	No
Do factors like malnutrition and lack of	15 (37.5%)	24 (60%)	1 (2.5%)
personal care contribute to crown failure?			
Do psychological factors like anxiety and stress	30 (75%)	0	10 25%)
affect crown success?			
Do genetic factors contribute to crown failure?	22 (55%)	0	18 (45%)
Does the quality of materials used in crowns	40 (100%)	0	0
impact their success?			
Do installation methods and adhesive	32 (80%)	0	8 (20%)
materials affect crown failure?			
Is the difference in color between crowns and	23 (57.5%)	0	17 (42.5%)
natural teeth a cause of failure?			
Is the choice of adhesive cement a critical	32 (80%)	0	8 (20%)
factor?			
Do poor sealing of crown edges and poor	36 (90%)	0	4 (10%)
adhesive cement lead to deterioration?			
Are dental crowns' failures usually due to	10 (25%)	0	30 (75%)
patient-related factors?			



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Are dentist-related errors the main cause of crown failure?	17 (42.5%)	0	23 (57.5%)
Is the dental technician often responsible for crown failure?	21 (52.5%)	0	19 (47.5%)
Is there a strong relationship between tooth decay and crown failure?	23 (57.5%)	14 (35%)	3 (7.5%)
Does the doctor's guidance impact crown success?	30 (75%)	10 (25%)	0
Are there common failure causes between dentists and technicians?	40 (100%)	0	0
Does patient cooperation influence the success of crowns?	31 (77.5%)	8 (20%)	1 (2.5%)
Does proper sanding play a role in crown success?	35 (87.5%)	5 (12.5%)	0

DISCUSSION

The aim of this research was to analyze the different mechanical and interpersonal factors important in dental crown failures that take place in professional dental procedures. The rightful life of dental crown grows doubled by first this collection of research documents sustains or presents that evidence at odds with these findings, an augment in understanding of what measures need to remain extended. Insufficient dental preparation and ambiguous dental abutment termination line are the main causes of crown failure as indicated by data. The results agree with Morgano S.M. [11] who showed that the dental preoperational procedures that are improper with out of definition the termination lines, negatively affects the fit and retention of the dental crowns. One study stated that the best preparation technique assures the secure foundation and prevents the failure of the crown unit along with the components .[12]

To ensure success of crowns, proper tooth preparations need distinct abutment lines. Research shows that poor nutrition combined with inadequate personal care practices result in a high degree of crown failure. Poor nutrition as a factor which weakens oral health so it can threaten dental restorations was stated by Antoniadou and Varzakas [13]. Those who are not performing proper oral hygiene practices have added risk for developing such dental problems that can later complicate the disease. Maintaining schedule of routine crown maintenance activities together with patient education about hygienic care of crown guarantees its lasting apex success. Results of this research show that aesthetic problems as much as biomechanical ones make primary causes for failure of tooth crowns. By various research Tombjörner & Fransson [14] have confirmed that patient satisfaction with crown appearance and functionality is the main determinant for long term successful results. Besides the unsatisfactory appearance, misfit of crowns leads to patient dissatisfaction and increases the risk of failure.

The important sanding process that is necessary to the dental crown manufacturing plays an important role in the crown longevity. Other researchers such as Söderholm [15] emphasize that unsuitable sanding drastically degrades the strength of material and therefore the crown fails soon. This phase must be executed by the technician in a proper technical procedure to guarantee crown outcomes. The research results clearly illustrate the significant link between dental crown failure and tooth caries, and in this regard, untreated carious teeth as well as gum infections appears as the main causes of crown failure. Studies such as [16, 17] showed that caries along with gingival infections are the causes for major complications of post placement.



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CONCLUSION

The research findings identify many crucial elements as main drivers of crown failure. Key factors include insufficient tooth preparation and imprecise termination lines of the dental abutment. underscoring the necessity for meticulous tooth preparation. Moreover, emphasizing the necessity of educating patients on fundamental dental hygiene and general health, factors like as hunger, inadequate personal care, and genetic predispositions have been identified as contributors to crown failure. The enduring efficacy of dental crowns is significantly dependent on the installation methodology and the application of adhesive substances; thus, appropriate training for both dentists and technicians is essential for achieving optimal results. The collaboration between the dentist and the dental technician is crucial, as their joint choices of materials, colors, and tooth preparation significantly influence both functional and aesthetic results. The success of the crown is significantly reliant on patient acceptance and cooperation with the dentist, especially on compliance with maintenance protocols. Moreover, the sanding process and the quality of materials utilized in crown fabrication were demonstrated to be essential for success, highlighting the necessity for skilled individuals and high-quality materials. Ultimately, prolonging the longevity of dental crowns and preventing failure over time mostly relies on sustaining gingival health and averting decay and infections in adjacent teeth.

Limitations

This study offers significant insights; nonetheless, certain limitations must be recognized :

1 .The study's findings, derived from a limited sample size of forty individuals, may lack generalizability to broader populations. To validate the findings, an extensive demographic analysis is required.

2 .Subjectivity in responses: The dependence on subjective feedback from participants may have led to prejudice or inaccuracies in articulating the causes of crown failures. Objective clinical assessments would enhance the results .

3 .The study concentrated mostly on a certain set of specified characteristics that lead to crown failure, hence limiting the array of components considered. Future research may examine supplementary elements, such as environmental influences or technical innovations in dental materials, that might impact crown durability.

4 .This study is deficient in long-term follow-up data on the implanted crowns, which would have been beneficial for comprehending the actual causes of failure over time .

Conflict of interest

The authors declare that no conflict of interest.

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