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Research Article

Evaluation of Failure Factors of Fixed Prosthesis in a Sample of Yemeni Dental Patients - Sana'a City

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Abstract

Tooth loss is a prevalent global health issue. The World Health Organization (WHO) estimates that nearly 7% of individuals aged 20 or older have complete tooth loss, increasing to 23% for those aged 60 or older. Fixed partial dentures (FPDs) are a common restorative option but often face failure.

Aim: This study investigated factors contributing to FPD failure in Yemeni patients.

Methods: A cross-sectional study was conducted on 208 FPD failure cases from 117 patients. Clinical examination, periodontal probing, and radiographic assessment were performed. Data on biological, mechanical, and aesthetic failures were collected.

Results: Biological factors accounted for 75% of failures, followed by aesthetic (18%) and mechanical (7%). The primary biological contributors were poor oral hygiene, periodontal problems, and food impaction. The most common mechanical failures were prosthesis fractures and dislodgements. Shade mismatch was the primary aesthetic issue.

Conclusion: FPD failures in Yemeni patients were primarily attributed to biological factors, emphasizing the importance of oral hygiene and periodontal health maintenance. Addressing these factors is crucial for the long-term success of FPDs.

Keywords: fpds; fixed partial denture failures; crown and bridge failures

Introduction

Teeth serve vital functions in daily life, including chewing, communication, and facial aesthetics. Tooth loss, a common global issue, primarily stems from untreated caries and periodontal disease, but can also result from trauma or congenital absence. To address this, fixed partial dentures (FPDs) are frequently used to replace missing teeth.

FPDs can significantly improve a patient's quality of life by restoring function and aesthetics. However, their success depends on various factors, including patient care, clinician expertise, and prosthesis quality. Biological, mechanical, and aesthetic complications can lead to FPD failure, impacting patient satisfaction and overall oral health.

While FPDs offer a promising solution for tooth loss, understanding the factors that contribute to their failure is essential for optimizing treatment outcomes and ensuring long-term patient well-being. This study aimed to investigate the prevalence and types of FPD failures in a Yemeni population.

Materials and Methods

Study Design

This cross-sectional clinical study was conducted between June 2020 and August 2022 at the Departments of Conservative Dentistry in the Faculty of Dentistry, Sana'a University and the University of Science and Technology, Sana'a, Yemen.

Study Site and Population

Participants were recruited from patients attending the polyclinics of the Faculty of Dentistry and the University of Science and Technology. All subjects were adults, regardless of gender.

Sample Size Calculation

A sample size of 208 fixed partial dentures (FPDs) was calculated using the following formula:

$n = (z^2 * \hat{p} * (1 - \hat{p})) / \varepsilon^2$

Where:

• n is the desired sample size

• z is the number of standard deviations (1.44 for an 85% confidence level)

• $\hat{p}$ is the estimated proportion of the outcome in the target population (set at 50% for a maximum estimate of FPD prevalence in the Yemeni population)

• ε is the maximum size of the standard error (set at 5%)

Sampling Method

Randomized sampling was employed to select Yemeni dental patients attending the Faculty of Dentistry, Sana'a University, and the University of Science and Technology.

Inclusion Criteria

• Subjects must be adults aged 18-50 years.

• Subjects must have crowns or bridges.

Exclusion Criteria

• Medically compromised conditions.

• Complete edentulous patients.

• Pregnant women.

• Individuals over 50 years old.

Study Methods

Patient Selection: Patients who met the inclusion criteria and did not have any exclusion criteria were included in the study.

Data Collection:

• **Case Sheet:** A standardized case sheet was used to collect patient information, including medical and dental history, intraoral examination findings, and information about the fixed prosthesis.

• **Examination Instruments:** Mirror, tweezer, explorer, periodontal probe, and dental x-rays (periapical or panoramic) were used for clinical examination.

• **Data Collection Procedure:** Patients attending dental clinics were examined clinically for fixed prostheses. A detailed case sheet was completed for patients with issues related to their crowns or FPDs.

• Failure Factors: Biological, mechanical, and aesthetic factors were assessed. Biological factors included periapical lesions, gingivitis, periodontitis, secondary caries, mobility, poor oral hygiene, bone resorption, and abscess formation. Mechanical factors included dislodged prosthesis, fracture of an abutment, prosthesis fracture, traumatic occlusal force, and loss of restoration along with abutment teeth. Aesthetic factors included shade mismatch and contour discrepancies.

Statistical Analysis: Descriptive statistics, including mean, standard deviation, and percentages, were used to analyze the collected data.

Note: The specific examination methods for each failure factor have been provided in **Table 1.**

Table 1: The Examination Methods of Fixed Prosthesis Failure Factors

Cause	Examination Method
Periapical lesion	Periapical x-ray
Gingivitis	Bleeding on probing
Periodontitis	Pocket depth
Secondary caries	Probing on the margin of restoration
Mobility	Degree of Horizontal mobility
Poor oral hygiene	Brushing and plaque accumulation
Bone resorption	Periapical x-ray
Pain and swelling	Patient history
Abscess formation	By vision and patient history
Shade mismatch and Contour discrepancies	By vision
Fracture of an abutment	Periapical x-ray
Prosthesis fracture	By vision

Results

A total of 208 fixed partial dentures (FPDs) were analyzed from 117 participants (89 females and 28 males, mean age: 35.76 ± 8.06 years). Participants' demographic characteristics and academic levels are summarized in (**Tables 2&3&4)**

Table 2: Demographic information of the study participants

Gender	Number of participants	Number of FPDs
Female	89 (76%)	162 (78%)
Male	28 (24%)	46 (22%)
Total	117	208

Table 3: The mean age of the study participants

Age (Mean ± SD)	Female	Male	Total
36.55 ± 7.57	33.25 ± 9.17	35.76 ± 8.06	

Table 4: The academic level of the study participants

Academic Level	Female (n = 89)	Male (n = 28)	Total (n = 117)
Illiterate	44	2	46
Primary	47	8	55
Middle	13	3	16
High	19	9	28
College	39	24	63

FPD Characteristics

• **Age:** 56% of FPDs were at least five years old, followed by 30% aged two to four years, and 14% less than one year.

• **Material:** All the studied FPDs were PFM. It has been not found that FPDs made of all ceramic, all metal, or any other materials.

• **Position:** 106 FPDs were in the upper arch, while 102 were in the lower arch.

• **Location:** 70% of FPDs were posterior, 16% anteroposterior, and 14% anterior.

• **Units:** 30% of FPDs had one unit, 30% had three, 22% had two, and 18% had at least four units.

Material used

Material of Prosthesis	No. of cases (n = 208)	Percentage %
PFM	208	100%
All ceramic	0	0%
All metal	0	0%
Others	0	0%

Table 5: Material of Prosthesis

As seen in Table 5, all of the fixed partial dentures (FPDs) analyzed in the study were made of porcelain-fused-to-metal (PFM). No other materials, such as all ceramic or all metal, were found in the sample. This indicates that PFM is the predominant material used for FPDs in the Yemeni population studied.

The Relationship Between Failure Factors and Various Variables

The study examined the relationship between FPD failure and several factors, including age, academic level, brushing frequency, prosthesis age, position, location, and number of units. The findings are summarized in **Tables 6-13.**

This table provides an overview of the most common failure factors, with poor oral hygiene, periodontal problems, shade mismatch, and food impaction being the primary contributors.

Failure Factors	Percentage %
Poor oral hygiene	19%
Periodontal problem (gingivitis/periodontitis)	17%
Shade mismatch	15%
Food impaction	13.3%
Secondary caries	12.7%
Pain	6%
Periapical lesion	5%
Prosthesis fracture	4%
Contour discrepancies	3%
Dislodged prosthesis	2%
Mobility	1%
Abscess formation	1%
Fracture of an abutment	0.6%
Swelling	0.4%
Loss of restoration along with abutment teeth	0%

Table 6: Prevalence of Failure Factors

Prevalence of Failure Factors in Descending Order

• Younger patients (≤34 years old): More likely to experience mechanical failures like dislodged prosthesis and prosthesis fracture.

• Older patients (>34 years old): More likely to experience biological failures like periodontal problems, food impaction, and poor oral hygiene.

Type of Failure	Failure Factors	≤ 34 years old	> 34 years old
Biological failure	Periodontal problem (gingivitis/periodontitis)	53 (28%)	82 (20%)
	Food impaction	28 (15%)	76 (19%)
	Poor oral hygiene	44 (24%)	100 (24%)
	Mobility	0 (0%)	8 (2%)
	Periapical lesion	13 (7%)	28 (7%)
	Secondary caries	27 (14%)	76 (19%)
	Bone resorption	0 (0%)	3 (0.9%)
	Pain	16 (9%)	31 (7%)
	Swelling	0 (0%)	1 (0.2%)
	Abscess formation	5 (3%)	3 (0.9%)
Mechanical failure	Dislodged prosthesis	11 (55%)	6 (19%)
	Fracture of an abutment	1 (5%)	2 (7%)
	Prosthesis fracture	8 (40%)	23 (74%)
	Loss of restoration along with abutment teeth	0 (0%)	0 (0%)
Esthetic failure	Shade mismatch	38 (83%)	80 (82%)
	Contour discrepancies	8 (17%)	18 (18%)
Total		32%	68%

Failure Factors Concerning Age

Table 7: Failure Factors Concerning Age

• Lower education levels (illiterate, primary): Higher rates of periodontal problems, food impaction, and poor oral hygiene.
• Higher education levels (college): Higher rates of shade mismatch and contour discrepancies.

Failure Factors	Illiterate	Primary	Middle	High	College
Periodontal problem	29 (15%)	32 (13.5%)	12 (23%)	22 (21%)	39 (20%)
Food impaction	28 (14%)	31 (13%)	7 (14%)	11 (11%)	29 (14.5%)
Poor oral hygiene	38 (20%)	46 (19%)	12 (23%)	17 (16%)	28 (14%)

Mobility	5 (2%)	3 (1%)	0 (0%)	0 (0%)	0 (0%)
Periapical lesion	12 (6%)	11 (5%)	1 (2%)	2 (2%)	15 (7%)
Secondary caries	25 (13%)	32 (13.5%)	8 (15%)	16 (16%)	22 (11%)
Bone resorption	0 (0%)	2 (1%)	0 (0%)	1 (1%)	1 (0.5%)
Pain	9 (5%)	19 (8%)	2 (4%)	5 (5%)	11 (5%)
Swelling	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Abscess formation	3 (2%)	2 (1%)	0 (0%)	0 (0%)	3 (1.5%)
Dislodged prosthesis	5 (2%)	2 (1%)	0 (0%)	2 (2%)	8 (4%)
Fracture of an abutment	0 (0%)	1 (0.5%)	0 (0%)	0 (0%)	2 (1%)
Prosthesis fracture	5 (2%)	15 (6.5%)	1 (2%)	6 (6%)	5 (2.5%)
Shade mismatch	29 (15%)	30 (13%)	8 (15%)	15 (15%)	35 (17%)
Contour discrepancies	6 (3%)	10 (4%)	1 (2%)	5 (5%)	4 (2%)
Total	195 (25%)	236 (30%)	52 (6.5%)	102 (13%)	202 (25.5%)

Table 8: Failure Factors Concerning Academic Level

Failure Factors Concerning Academic Level

- Lack of brushing: Significantly higher rates of all failure factors.
- Consistent brushing: Lower rates of failure factors.

Failure Factors	**Once**	**Twice**	**Three times**	**No brushing**
Periodontal problem	41 (16%)	7 (24%)	0 (%)	85 (16%)
Food impaction	34 (13%)	4 (13%)	0 (%)	65 (12%)
Poor oral hygiene	34 (13%)	2 (7%)	0 (%)	111 (20.5%)
Mobility	3 (1%)	0 (0%)	0 (%)	5 (1%)
Periapical lesion	13 (5%)	2 (7%)	0 (%)	27 (5%)
Secondary caries	25 (9.5%)	1 (3%)	0 (%)	76 (14%)
Bone resorption	1 (0.5%)	0 (0%)	0 (%)	3 (0.5%)
Pain	16 (6%)	3 (10%)	0 (%)	28 (5%)
Swelling	0 (0%)	0 (0%)	0 (%)	1 (0.2%)
Abscess formation	2 (1%)	1 (3%)	0 (%)	5 (1%)
Dislodged prosthesis	5 (2%)	1 (3%)	0 (%)	11 (2%)
Fracture of an abutment	7 (3%)	1 (3%)	0 (%)	2 (0.3%)
Prosthesis fracture	35 (14%)	0(0%)	0 (%)	25 (5%)
Shade mismatch	35 (14%)	7 (24%)	0 (%)	77 (14%)
Contour discrepancies	6 (2%)	1 (3%)	0 (%)	19 (3.5%)
Total	257 (30.5%)	30 (3.5%)	0 (0%)	551 (66%)

Failure Factors Concerning Brushing Frequency

Table 9: Failure Factors Concerning Brushing Frequency

• Newer prostheses (≤2-4 years): Higher rates of periodontal problems, food impaction, and poor oral hygiene.

• Older prostheses (≥5 years): Higher rates of shade mismatch and contour discrepancies.

Failure Factors	**≥ 1 year**	**2-4 years**	**≤ 5 years**
Periodontal problem	16 (18.5%)	43 (19%)	74 (16%)
Food impaction	10 (11.5%)	29 (13%)	64 (13.5%)
Poor oral hygiene	17 (19.5%)	44 (19%)	86 (18%)
Mobility	0 (0%)	1 (0.5%)	7 (1.5%)
Periapical lesion	2 (2%)	14 (6%)	26 (5.5%)
Secondary caries	3 (3.5%)		

Failure Factors Concerning the Age of the Prosthesis

Table 10: Failure Factors Concerning the Age of the Prosthesis

• Lower prostheses: Slightly higher rates of periodontal problems, food impaction, and poor oral hygiene compared to upper prostheses.

Failure Factors	Upper	Lower
Periodontal problem (gingivitis/periodontitis)	69 (18%)	63 (15.5%)
Food impaction	49 (13%)	54 (13%)
Poor oral hygiene	75 (19.3%)	72 (18%)
Mobility	3 (0.7%)	5 (1%)
Periapical lesion	13 (3.3%)	28 (7%)
Secondary caries	56 (14.5%)	47 (12%)
Bone resorption	0 (0%)	4 (1%)
Pain	17 (4%)	31 (8%)
Swelling	1 (0.2%)	0 (0%)
Abscess formation	4 (1%)	4 (1%)
Dislodged prosthesis	9 (2.5%)	8 (2%)
Fracture of an abutment	3 (0.7%)	0 (0%)
Prosthesis fracture	15 (4%)	16 (4%)
Shade mismatch	56 (14.5%)	63 (15.5%)
Contour discrepancies	17 (4.3%)	9 (2%)
Total	387 (49%)	404 (51%)

Failure Factors Concerning the Position of the Prosthesis

Table 11: Failure Factors Concerning the Position of the Prosthesis

• Posterior prostheses: Significantly higher rates of failure compared to anterior or anteroposterior prostheses.

Failure Factors	Anterior	Posterior	Anteroposterior
Periodontal problem	19 (18%)	96 (18%)	19 (13%)
Food impaction	9 (8.3%)	73 (13.5%)	21 (14.5%)
Poor oral hygiene	22 (20.2%)	97 (18%)	28 (19.5%)
Mobility	3 (2.5%)	4 (0.5%)	1 (0.5%)
Periapical lesion	3 (2.5%)	30 (5.5%)	9 (6.5%)
Secondary caries	16 (15%)	66 (12%)	20 (14%)
Bone resorption	0 (0%)	3 (0.5%)	1 (0.5%)
Pain	3 (2.5%)	36 (6.8%)	9 (6.5%)
Swelling	1 (1%)	0 (0%)	0 (0%)
Abscess formation	2 (2%)	4 (0.5%)	2 (1.5%)
Dislodged prosthesis	3 (2.5%)	11 (2%)	3 (2%)
Fracture of an abutment	0 (0%)	1 (0.2%)	2 (1.5%)
Prosthesis fracture	4 (4%)	22 (4%)	6 (4%)
Shade mismatch	16 (15%)	84 (15.5%)	18 (12.5%)
Contour discrepancies	7 (6.5%)	15 (3%)	5 (3.5%)
Total	108 (14%)	542 (68%)	144 (18%)

Failure Factors Concerning the Number of Units

Table 12: Failure Factors Concerning the Location of the Prosthesis

• 3-unit prostheses: Highest rates of failure, primarily due to periodontal problems, food impaction, and poor oral hygiene.

Failure Factors	1 unit	2 units	3 units	≤ 4 units
Periodontal problem	38 (17%)	32 (17.5%)	41 (17%)	23 (15.5%)
Food impaction	33 (14.5%)	23 (13%)	25 (10.5%)	23 (15.5%)
Poor oral hygiene	38 (17%)	34 (19%)	44 (18.5%)	31 (20.5%)
Mobility	2 (1%)	2 (1%)	3 (1%)	1 (0.5%)
Periapical lesion	13 (6%)	11 (6%)	9 (4%)	8 (5.5%)
Secondary caries	29 (13%)	25 (14%)	27 (11%)	23 (15.5%)
Bone resorption	1 (0.5%)	2 (1%)	0 (0%)	1 (0.5%)
Pain	11 (5%)	9 (5%)	20 (8.5%)	8 (5.5%)
Swelling	0 (0%)	0 (0%)	1 (0.5%)	0 (0%)
Abscess formation	1 (0.5%)	1 (0.5%)	5 (2%)	0 (0%)
Dislodged prosthesis	4 (2%)	3 (1.5%)	6 (2.5%)	4 (2.5%)
Fracture of an abutment	2 (1%)	0 (0%)	1 (0.5%)	0 (0%)
Prosthesis fracture	6 (2.5%)	6 (3%)	13 (5.5%)	9 (6%)
Shade mismatch	41 (18%)	28 (15.5%)	33 (14%)	15 (10%)
Contour discrepancies	5 (2%)	6 (3%)	10 (4.5%)	4 (2.5%)
Total	224(26.5%)	182(21.5%)	283 (34%)	150 (18%)

Failure Factors Concerning the Number of Units

Table 13: Failure Factors Concerning the Number of Units

Overall Analysis: The study found that biological factors, such as poor oral hygiene and periodontal disease, were the primary contributors to FPD failure. However, mechanical and aesthetic factors also played a significant role. Factors like age, education level, brushing habits, prosthesis age, position, location, and number of units all influenced the likelihood of FPD failure.

Discussion

This study investigated the factors contributing to FPD failures in a sample of 208 patients in Yemen. Here's a breakdown of the key findings:

• Biological Failures: This study aligns with previous research highlighting biological factors as the primary cause of FPD failures. Poor oral hygiene, periodontal disease, and secondary caries were consistent contributors.

• Mechanical Failures: While less common, mechanical failures, such as fractures and dislodgement, are in line with previous reports.

• Esthetic Failures: Shade mismatch and contour discrepancies were significant aesthetic concerns, consistent with prior studies.

• Oral Hygiene: The strong association between poor oral hygiene and FPD failures is supported by existing literature, emphasizing the importance of preventive care.

• Age and FPD Location: The findings regarding older age and posterior FPD placement being associated with higher failure rates are consistent with previous research.

Contrasting Findings:

• Distribution of Failures: This study deviates from some previous research by finding a higher rate of biological failures compared to mechanical failures. This may be due to variations in study populations, methodologies, or regional differences.

• Number of Units: The lack of a clear relationship between the number of units in an FPD and failure rate contradicts some previous studies. This could be attributed to factors like material quality, fabrication techniques, or patient-specific factors.

Overall, this study provides valuable insights into FPD failures in Yemen and contributes to the growing body of knowledge in this area. While some findings align with previous research, the discrepancies highlight the need for further investigation to understand the complex interplay of factors influencing FPD longevity. Future studies could explore the impact of material selection, fabrication techniques, and patient-specific factors in greater detail.

Conclusions and Recommendations

Limitations

• Radiographic Limitations: The use of two-dimensional radiography may have limited the sensitivity of the study, as compared to three-dimensional imaging, for assessing various parameters. This was due to financial constraints and the desire to minimize patient radiation exposure.

• Age of Prosthesis: The inability to determine the exact age of many prostheses due to patients' lack of recall was a limitation.

Conclusions

Within the limitations of this study, the following conclusions can be drawn:

• Failure Factors: The factors contributing to FPD failures were categorized into three primary groups: biological, mechanical, and aesthetic.

o Biological: Poor oral hygiene, periodontal problems, food impaction, secondary caries, pain, periapical lesions, mobility, abscess formation, and swelling.

o Mechanical: Prosthesis fracture, dislodged prosthesis, fracture of an

abutment, and loss of restoration along with abutment teeth.

o Aesthetic: Shade mismatch and contour discrepancies.

• Relationships: There were relationships between failure factors and brushing frequency, number of units, location, and age of the prosthesis.

• No Relationship: No significant relationships were found between failure factors and academic level, gender, or position of the prosthesis (maxillary or mandibular).

• Combined Failures: Some cases exhibited multiple failure reasons, with biological, mechanical, and aesthetic factors contributing in varying combinations.

Recommendations

• **Recall System:** Establishing a proper recall system for patients who have undergone fixed prosthodontic work is recommended to facilitate early detection and management of complications.

• **Material Evaluation:** Further studies are needed to investigate the factors influencing the choice of materials for crown and bridgework within the institution. The materials used can significantly impact the success rate and associated complications of these prostheses.

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