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Analysis of Factors Contribute to Failure of Dental Restorations and Its Impact on Patient's Life

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ABSTRACT

Background: Dental restoration focuses on repairing or replacing damaged or missing teeth, but it has a limited lifespan and leads to significant health issues throughout a patient's life. This study analyzed the potential factors contributing to dental restoration failure and its impact on the patient's life.

Methods: This was a descriptive cross-sectional study conducted in 2 hospitals, Lady Reading Hospital, Peshawar, and Ayub Teaching Hospital, Abbottabad, KPK. The study comprised 167 patients, both genders, ages 10 to 60 years. Data was collected through a self-administered questionnaire in 4 months and analyzed by SPSS statistics software version 29. **Results:** Out of 167 study participants, 70 were male, while 92 were female. The most frequently reported reason was tooth erosion (46.7%), followed by secondary caries (26.3) ($p < .001$), fractures (in the tooth (1.7%), and restorations (11.3%) ($p < .001$), resulted in dislodgment (64.6%) ($p = .734$) and unexpected fallout (55%) of restorations ($p = .015$). Females experienced a higher failure rate (58%) as compared to males (42%), leading to multiple visits and time-consuming procedures impacting patients' daily routine, work, and personal commitments, reported by (33.5%) of individuals, followed by experiencing severe pain (32.3%) and being costly (27.5%) ($p = .021$). **Conclusion:** This study in the KPK region revealed that tooth erosion, secondary caries, and fractures (both in the tooth and restorations themselves) were significant contributors to filling dislodgment and unexpected fallout, leading to the failure of restorations.

Keywords: Restoration Failure, Amalgam Failure, Composite Failure, Glass Ionomer Failure, Dental Restorations Failure

INTRODUCTION

Cavities, affecting approximately 80% of individuals in developed countries, pose a significant dental health challenge, potentially leading to pain and even tooth loss if left untreated. Removing and restoring the damaged tissue with dental restorations is necessary to mitigate these issues. Restorations have a limited lifespan and are often replaced multiple times throughout a patient's life. Research in the UK indicated that a significant portion (around 60%) of restorative dental procedures involve replacing existing restorations [1]. Similar research has been observed in other parts of Europe and the United States [2]. Millions of dental restorations are placed each year, but a considerable number of them fail over time. The prevalence of restoration failure varies among different studies. It is estimated that approximately one-third of all restorations placed at any given time can be considered failed for various reasons [3]. The reasons for replacing dental restoration are diverse and may vary with the

type of tooth and restoration material [4]. Multiple factors contribute to restoration failure, such as smoking, alcohol consumption, genetic predisposition, and the enzyme MMP 2 (matrix metalloproteinase 2) [5]. Additional reasons encompass esthetic concerns, filling detachment, marginal leakage, fractured teeth, and recurrent caries [6-9]. Early failure can also occur due to restoration fracture and defective marginal adaptation [10]. Olaleye et al. (2020) provided evidence of fractured restorations, defective margins, secondary caries, and dislodge restorations, alongside issues like overcharged amalgam restorations, cervical abrasion, attrition, and iatrogenic preparation [10].

Moreover, problems such as overhangs, voids, open contact points, poor contour, open margins, residual caries, retention loss, defective size, carious lesion extension, and patient-related factors like finance can also contribute to restoration failure [11-13]. Additional reasons for replacement include root canal therapy, tooth discoloration, lost restorations, composite fracture, and pain or sensitivity [14]. Secondary caries and fractures further complicate the matter [15], with faulty cavity preparation, marginal discoloration, and poor marginal adaptation linked to recurrent caries and restoration replacement [16]. In class IV restorations, restorative fracture is the primary cause of failure [17]. Failures are often attributed to dental filling techniques and material selection issues, with secondary tooth decay becoming more prevalent [18]. Commonly cited problems include inadequate contour, cavity preparation, and adaptation to the tooth's natural features, often related to improper cavity designs or preparations [3]. A previous study by Ahmed et al. from Pakistan demonstrated evidence of recurrent caries leading to the failure of amalgam fillings [19].

Similarly, class IV and II dental restorations have higher rates of failures than Class I options, with both very young patients under 20 and elderly patients over 60 more likely to have failed restorations than patients between the ages of 20 and 60 years old [20]. Females experienced replacements more frequently, with a mean age of 37 years [21]. Maxillary posteriors and more extensive restorations have a higher risk of failure [22]. Resin-based composite restorations had a higher risk of replacement than amalgam restorations [23]. The degradation of the bond between tooth structure and material is significant cause for the failure of restorations [24]. Filling failure can have profound clinical implications, including infection, pulpitis, and tooth loss, making it crucial to identify the causes to prevent future issues. The cost of replacing a failed filling can also be significant. Current literature reveals that the frequency and causes of dental restoration failure are numerous, including material wear, formation of new carious lesions, and patient factors. In contrast, the quantitative effects of these failures on quality of life have only been studied to a limited extent. In this dissertation, the author will explore the causes of failed dental restorations and assess the importance of the impact on general patient health and their psychological and financial status to learn about their prevention and treatment.

MATERIALS AND METHODS

This descriptive cross-sectional study was based on a self-administered questionnaire, where participants voluntarily chose to participate. This research study was conducted at Lady Reading Hospital, Peshawar, and Ayub Teaching Hospital, Abbottabad, in Khyber Pakhtunkhwa. These healthcare settings were chosen due to their accessibility and availability to a diverse patient population. The questionnaire was developed based on a thorough review of relevant literature and research objectives. It consisted of 27 questions, encompassing closed-ended answers. There were two sections of the questionnaire; the 1st section had demographic details such as name, age, gender, and education, while the 2nd section reported signs and symptoms, causes, and impacts of restoration failure. The research study lasted 4 months, from 1 March 2023 to 30 June 2023. The research activities were distributed across the 4 months. During the initial phase of the study, approximately 3 months were dedicated to developing a questionnaire and collecting data—finally, the data analysis phase involved organizing and interpreting data to address the research objectives. The sample size of 167 participants was determined to be appropriate based on various factors, including research objectives and available resources. A convenient sampling approach was employed to recruit the participants for this study. Inclusion criteria for participants included dental patients with failed restorations and their past medical and dental history, aged ≤ 18 to 60 years, including male and female. Participants' responses were marked in the questionnaire. Uncooperative dental patients and those who didn't have past medical and dental history were excluded from the study. All participants clearly explained the study objective and procedures and their rights as participants. Informed consent was obtained from each participant before they were involved in the study. No personally identifiable information from the patients was

collected, and all the data were analysed in an aggregated and anonymous manner to maintain the privacy and confidentiality of the patients. Finally, the data analysis using IBM SPSS Statistical software version 29.0.1.0 determined the statistics and frequencies of all variables. Variables were compared through cross tabs, and the significance between variables was found in the Chi-Square Test. The ethical approval letter and consent form were obtained from the institutional review boards of the involved institutions. The current research employed a descriptive design to examine the causes of dental restoration failure.

DATA COLLECTION PROCEDURE

This descriptive cross-sectional study was conducted over four months (March–June 2023) at Lady Reading Hospital, Peshawar, and Ayub Teaching Hospital, Abbottabad, using a 27-item self-administered questionnaire. A sample of 167 dental patients aged 18–60 with failed restorations was recruited via convenience sampling. Data were collected anonymously, ethical approval was obtained, and SPSS version 29 was used for analysis, including Chi-square tests for significance.

STATISTICAL ANALYSIS

SPSS analysis used Chi-square tests to examine associations, showing significant gender differences in restoration failure impacts ($p = 0.021$) and material-specific causes ($p < 0.05$). Key findings include higher failure rates in females and significant factors like tooth erosion and secondary caries differing by material.

RESULTS

Out of 167 respondents, 97(58.08%) were female, and 70(41.92%) were male, indicating a higher failure rate in females as compared to males, as shown in (Figure 1.)

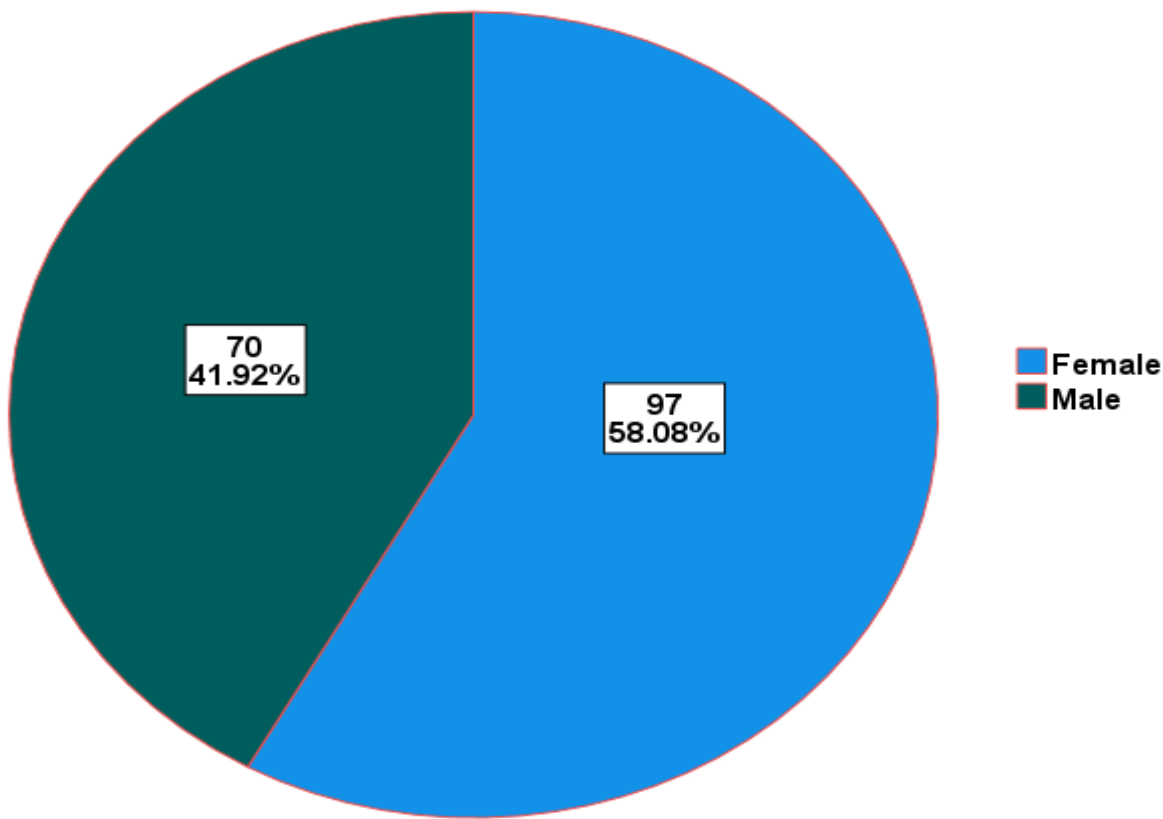


Figure 1: Shows Gender Wise Distribution among Survey Participants

The failure rate was higher among the age group of 31–45 years (49.70%), while the rest of the details are shown in (Figure. 2).

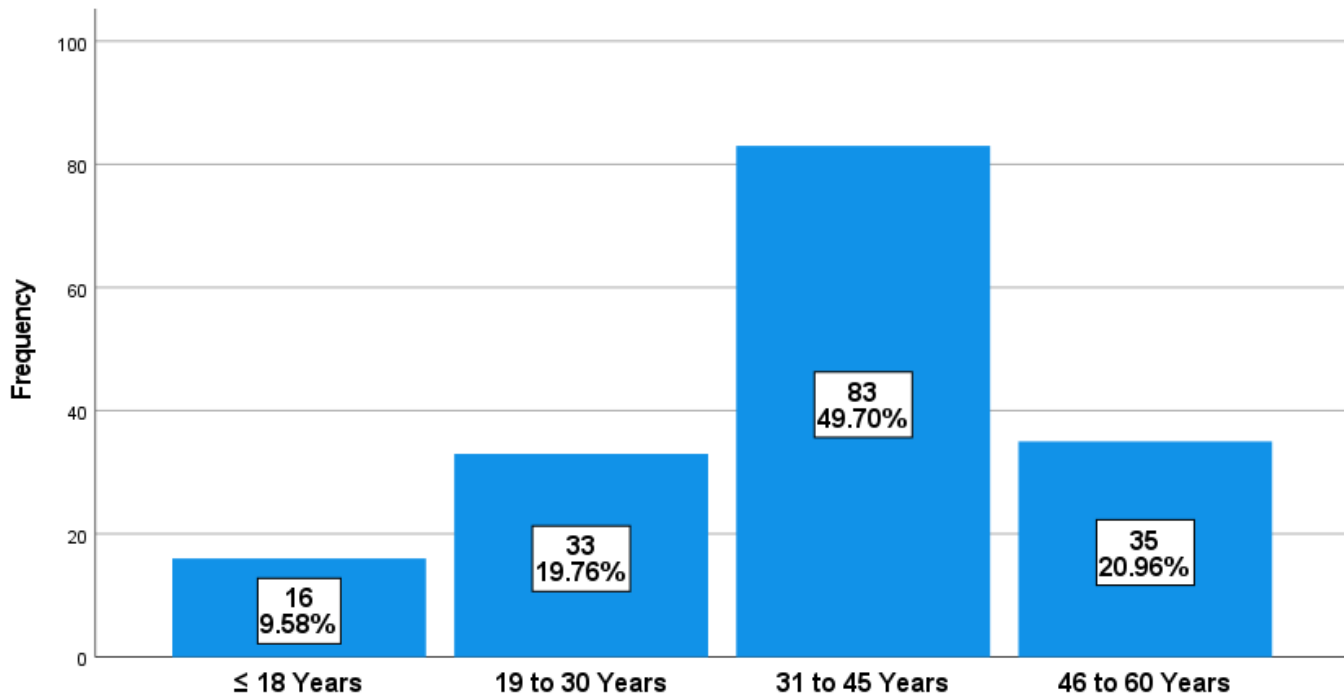


Figure 2: Patient's Age at the Time of Dental Restoration Failure

The most frequent cause for the failure of all three types of restorations was tooth erosion (46.7%). Additionally, secondary caries (26.3%), restoration fracture (11.3%), and tooth fracture (1.7%) result in filling dislodgement (64.6%) and unexpected fallout of restorations (55%) (Table. 1). The most common cause of composite resin failure is secondary tooth caries. The glass ionomer failed due to a restoration fracture. In contrast, amalgams failed due to secondary caries and tooth fractures. (Table. 1) The most reported impacts of restoration failure are multiple visits and time-consuming procedures impacting the patient's routine, work, and personal commitments (33.5%), followed by suffering from pain (32.3%), and being costly (27.5%) (Chi-square test, $p=.021$). Male respondents tend to report higher levels of suffering from severe pain, while female respondents more frequently mention the impact on their daily routine, work, and personal commitments. Additionally, a female respondent highlighted the financial burden associated with the condition. (Table 2)

Table 1: Causes of Failure of Dental Restorations

Causes	Amalgam	Composite	GIC	Total	%	p-value
Tooth Erosion	4	22	52	78	46.7	$p < .001$
Secondary Caries	22	16	6	44	26.3	$p < .001$
Restoration Fracture	0	0	19	19	11.3	$p < .001$
Tooth Fracture	3	0	0	3	1.7	$p < .001$
Others	Including poor technique, poor quality material, trauma, & excessive occlusal force applied to the area of restorations					

EFFECTS ON TEETH						
Dislodgment	15	40	49	108	64.6	p=.734
Unexpected Fallout	8	38	46	92	55	p=.015
LOCATION OF FAILED RESTORATIONS						
Front T	0	30	12	42	25	p <.001
Back T	27	12	51	90	53.8	
Both F & B Teeth	0	21	14	35	21	
Total	27(16%)	53(32%)	77(46%)	167	100	

A P-value less than 0.05 indicates a statistically significant relationship between variables.

Table 1 shows the Statistical Analysis and Significant Values for the Causes, Effects, and Locations of Dental restoration failure across Different Materials: Amalgam, Composite, and Glass Ionomer Cement (GIC). Statistically Significant relationships were found for most variables(p<0.05)

Table 2: Dental Filling Failure Impacts on Patient's Life

		Effecting overall health		Affecting self-esteem		Pain and Infection		Multiple visits affect my daily routine		Total	p-value
		Costly									
Are you male or female?	Male	0	17	0	29	24	70	p=.021			
	Female	7	29	4	25	32	97				
	Total	7	46	4	54	56	167				
	%	4.2	27.5	2.4	32.3	33.5	99.4				

A P-value less than 0.05 indicates a statistically significant relationship between variables.

Table 2 shows the statistical analysis of restoration failure effects on a patient's life, and women reported more issues associated with restoration failure than men. The difference between men's and women's failure ratios is statistically significant(p=0.021).

DISCUSSION

The failure and complications of dental restorations and their impact on patient's daily activity were explored in this work, whereby erosion of the teeth, secondary caries, and fractures were pinpointed as causes of the complications that result in dislodgement and /or fallout. In the first Pakistani study, these findings reveal the high personal and financial costs for patient care, including multiple, lengthy dental appointments, severe pain, and disruptions to daily lives. Some differences were apparent along the gender; for example, males scored higher on pain while females discussed limitations imposed by pain and the effects it had on finances. The results outlined, therefore, posed greater recognition of the need to advance strategies for increasing restoration durability while managing such difficulties for patients. These results support the study of Kattan et al. 2021. About 67% of patients reported that the most frequent patient-related factor was restricted patient finances [13]. For the causes of failure of fillings, among 167 patients, 97 (58%) were female, and 70 (42%) were male, with a mean age of 31-45 years (49.7%). This result supports the Study of Braga et al. 2007; according to him, failure of restorations was mostly seen in females as compared to males within the age of 37 years [21], but it does not support the theory of Wierichs et al. 2020 that the patients have the age of <20 years and >60 years showed 1.4 times higher failure rate of their restorations as compared to the patients, aged between 20 to 60(p<0.015) [20]. Restoration frequently failed in posterior teeth (53.8%). This result is consistent with the

study of Rodolpho et al. 2022, which found that the risk of failure of restoration was higher for maxillary posteriors and larger restorations [22].

According to Roumanas et al. 2010, a high failure rate was seen in posterior teeth [23]. In this study, secondary caries emerged as the second most frequent reason for restoration failure, predominately affecting amalgam and composite restorations. These results support the research of Asmar et al. 2023; according to them, secondary tooth caries and marginal detachment were the common reasons for failure of restorations [5]. Evidence of fracture of restorations: the chi-square test revealed a significant association between the type of dental filling and the evidence of fracture of restorations ($p < .001$). Glass ionomer cement had a higher incidence of fracture compared to amalgam and composite resin fillings. These results support the previous study by Heck et al. (2020), which stated that material fractures along with retention loss were the major causative factors of failure [12]. In the current study, fracture of teeth with a minor value of about (1.7%) is also seen as a causative factor for dental restorations with a significant value ($p < .001$). This result supports the study of Santos et al., 2023. The most frequent cause of failure of amalgam and composite restorations was tooth fracture [9]. Dental fillings failed because of poor technique when the clinician didn't follow proper protocol and clinical standards. This result supports the study of Drummond, 2008. Clinical studies revealed that within five years, failures were often associated with issues with dental filling techniques or the selection of restoration material [18]. As mentioned, the main reason for the failures was tooth erosion, highlighting the need for patient education about dietary habits and maintaining proper oral hygiene; the study also emphasized the necessity of improving restorative techniques and materials. Conducting future research with a larger sample size and longitudinal designs with long-term term follow-ups could provide more comprehensive insights into the factors influencing dental restoration.

LIMITATIONS AND RECOMMENDATIONS

A limitation of this study is its reliance on a single-centre survey with a relatively small sample size, which may limit generalizability. Future research should include larger, multi-centre studies to validate these findings and explore the long-term impacts of dental restoration failures across diverse populations and materials.

CONCLUSION

In conclusion, the research study highlighted tooth erosion as the primary cause of the restoration failure, followed by secondary caries and fractures (in both tooth and restoration itself); it results in filling dislodgment and unexpected fallout of the restorations, leading to the failure of dental fillings. Female patients were more likely to experience filling failures than males. It affects their lives by causing severe pain, requiring multiple visits to dental clinics, time-consuming procedures, and costly repairs after restoration failure, disrupting their daily routine, work, and personal commitments, and imposing a considerable financial burden on the patients.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article is reported.

AUTHOR CONTRIBUTION

Dr Amir Afzal Khan contributed to the manuscript preparation and provided critical analysis of the study. Sadaf Shah was responsible for data collection and analysis, ensuring the accuracy and integrity of the research findings. Dr Syed Izhar Ali Shah played a key role in topic selection and facilitated the data collection process. Haris Rahman initiated the research by proposing the core idea for the study.

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