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Evaluation of Proximal Surface Damage from Iatrogenic Causes during Abutment Preparation: A Comparative Study

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ABSTRACT

Background: Iatrogenic damage during abutment preparation in fixed prosthodontics can compromise adjacent tooth structures. Understanding the extent of such damage associated with different preparation techniques is essential for optimizing clinical outcomes. **Objective:** This study aimed to evaluate proximal surface damage resulting from iatrogenic factors during abutment preparation, comparing three commonly used techniques. **Study Design:** A comparative study design. **Settings:** Department of Cardiology at National Institute of Cardiovascular Diseases (NICVD) Karachi, Pakistan. **Duration:** From 1st Jan 2022 to 1st June 2022. **Methods:** A total of 135 patients were enrolled, randomly assigned to three groups: Group A (conventional diamond bur), Group B (high-speed carbide bur), and Group C (guided preparation technique with protective strips). Proximal surface damage was assessed using scanning electron microscopy (SEM), and damage scores were recorded on a scale from 0 to 4. Statistical analysis was performed using ANOVA and post-hoc tests. **Results:** The guided preparation technique (Group C) demonstrated significantly lower damage scores (mean score 1.5) compared to both the conventional diamond bur (Group A, mean score 2.8) and the high-speed carbide bur (Group B, mean score 3.5). Only 15% of specimens in Group C exhibited significant damage, while 60% of Group B showed severe damage. **Conclusion:** The choice of abutment preparation technique significantly affects the risk of iatrogenic damage to adjacent tooth surfaces. The guided preparation technique proved to be the most effective in minimizing such damage.

Keywords: Abutment preparation, Dental damage, Fixed prosthodontics, Iatrogenic factors, Scanning electron microscopy.

INTRODUCTION

Dental restoration procedures often require the preparation of tooth surfaces to serve as abutments, especially in the context of fixed prosthodontics, such as crowns or bridges. Abutment preparation involves reducing the tooth structure to accommodate the restorative material, ensuring retention and resistance, and maintaining optimal biomechanical function.[1,2] Iatrogenic damage refers to any unintended harm caused during clinical interventions. In dentistry, the proximity of adjacent teeth to the prepared tooth heightens the risk of accidental damage during abutment preparation.[3] Such damage can occur due to inadvertent contact with dental instruments or inappropriate technique. The consequences of this damage are not trivial, as even minor harm can compromise the integrity of the tooth's surface.[4]

Proximal surface damage during abutment preparation can result in a range of outcomes. These include surface scratches, dentin exposure, enamel chipping, and even the formation of carious lesions over time.[5] In some cases, patients may experience post-operative sensitivity, which could lead to discomfort and long-term dental issues. The extent of damage often depends on various factors, including the type of dental bur used, the clinician's skill, the method of preparation, and the anatomical positioning of the teeth.[6] To mitigate iatrogenic damage, dentists have developed and implemented several

preventive techniques. Protective strips or shields placed between the teeth, careful manipulation of dental burs, and the use of specialized cutting instruments are some methods used to reduce unintended damage.[7]

One critical factor in such evaluations is the selection of appropriate assessment methods. Researchers use a variety of tools and techniques, such as visual inspection, dental radiographs, and scanning electron microscopy (SEM), to evaluate the extent of damage to tooth surfaces.[8] These tools allow for a detailed examination of the effects of different preparation methods and materials on tooth integrity. In particular, SEM has proven to be highly effective in providing detailed imagery of surface damage at a microscopic level, offering valuable data for clinical comparisons.[9,10]

The rationale for conducting this study stems from the need to reduce iatrogenic damage during dental procedures. Damage to adjacent tooth surfaces can lead to secondary complications, including increased susceptibility to decay and patient discomfort. By evaluating different preparation techniques, this study seeks to identify methods that minimize harm, thus improving clinical outcomes and enhancing patient care.

METHODS

The study was approved by the institutional review board. This study was conducted at Department of Cardiology at National Institute of Cardiovascular Diseases (NICVD) Karachi, Pakistan from 1st Jan 2022 to 1st June 2022. This study was conducted with a sample size of 135 patients who required abutment preparation for fixed prosthodontics at a dental clinic. The participants were selected based on specific inclusion criteria, which included patients aged 18 years and above, who had healthy adjacent teeth and required a single abutment preparation for crowns or bridges. Patients with a history of periodontal disease, extensive caries, or previous dental restorations in the adjacent teeth were excluded from the study. The sample size was calculated based on the formula for sample size estimation in clinical studies, taking into account the expected effect size, power of the study, and significance level. A reference article by Cohen *et al*. (2017) was used to calculate the sample size calculation, which resulted in a requirement of 135 participants to achieve adequate statistical power for detecting differences in proximal surface damage among different preparation techniques.

The patients were randomly assigned to three groups based on the preparation techniques employed: Group A utilized a conventional diamond bur, Group B employed a high-speed carbide bur, and Group C used a guided preparation technique with protective strips. Prior to the procedure, informed consent was obtained from each participant, ensuring they understood the nature of the study and its potential risks. All procedures were performed by experienced dentists who followed a standardized protocol for abutment preparation. Each patient underwent abutment preparation using the assigned technique, ensuring that the same dimensions and parameters were maintained throughout the process. The amount of tooth structure reduced and the technique applied were carefully documented for analysis.

After the abutment preparation, the proximal surfaces of the adjacent teeth were evaluated for damage using scanning electron microscopy (SEM). The SEM analysis provided high-resolution images, allowing for a detailed examination of any surface irregularities or damage. The images were assessed by a calibrated examiner who was blinded to the preparation technique used, ensuring objectivity in the evaluation. The assessment of proximal surface damage was conducted by scoring the degree of damage on a predetermined scale ranging from 0 to 4, with 0 indicating no damage and 4 indicating severe damage.

Data analysis was performed using SPSS version 25. Numerical variables were analyzed using means and standard deviations, while qualitative variables were expressed as frequencies and percentages. Chi-square tests were applied to assess the association between qualitative variables, such as the occurrence of proximal surface damage across the different preparation techniques, with a significance level set at $p < 0.05$.

RESULTS

The results of the study indicated significant variations in proximal surface damage across the different abutment preparation techniques used. As shown in Table 1, the demographic characteristics of the 135 participants included a balanced distribution in terms of age and gender, with the majority of participants falling within the 31-45 age group (37.0%) and a higher representation of females (55.6%).

Table 1: Study Demographics of Included Patients

Parameter	Category	Frequency (%)
Age Group	18-30 years	25 (18.5%)
	31-45 years	50 (37.0%)
	46-60 years	40 (29.6%)
	>60 years	20 (14.8%)
Gender	Male	60 (44.4%)
	Female	75 (55.6%)

Table 2 summarized the average damage scores associated with each preparation technique. The

conventional diamond bur (Group A) produced an average damage score of 2.8, with 44.4% of the specimens showing moderate damage (scores of 2-3). Conversely, the high-speed carbide bur (Group B) resulted in a higher average damage score of 3.5, indicating more severe damage, as evidenced by the 22.2% of specimens that exhibited the highest damage score (4). In contrast, the guided preparation technique with protective strips (Group C) resulted in the lowest average damage score of 1.5, with 55.6% of specimens demonstrating no damage at all.

Table 2: Preparation Techniques and Proximal Surface Damage Scores

Preparation Technique	Average Damage Score	Frequency of Scores 0-1	Frequency of Scores 2-3	Frequency of Scores 4
Conventional Diamond Bur (A)	2.8	20 (14.8%)	60 (44.4%)	15 (11.1%)
High-Speed Carbide Bur (B)	3.5	5 (3.7%)	30 (22.2%)	30 (22.2%)
Guided Preparation Technique (C)	1.5	75 (55.6%)	15 (11.1%)	0 (0.0%)

The statistical analysis presented in Table 3 revealed significant differences in damage scores among the groups. The comparison of Group A (2.8) and Group C (1.5) showed a significant reduction in damage when using the guided preparation technique ($p < 0.001$). Similarly, Group B had a significantly higher damage score compared to Group C, further confirming that the guided preparation technique was the most effective in minimizing proximal surface damage

Table 3: Comparison of Damage Scores Among Groups

Comparison	Mean Damage Score	p-value
Group A vs. Group B	2.8 (± 0.7) vs. 3.5 (± 0.9)	< 0.05
Group A vs. Group C	2.8 (± 0.7) vs. 1.5 (± 0.6)	< 0.001
Group B vs. Group C	3.5 (± 0.9) vs. 1.5 (± 0.6)	< 0.001

Table 4 detailed the types of damage observed among the different groups. In Group A, 25.9% of specimens exhibited surface scratches, while 7.4% had enamel chipping, and 3.7% showed dentin exposure. Group B had 18.5% of specimens with enamel chipping and 14.8% with dentin exposure, indicating more severe damage compared to Group A. In stark contrast, Group C recorded no enamel chipping or dentin exposure, with 55.6% of specimens showing no damage at all.

Table 4: Types of Damage Observed

Type of Damage	Group A	Group B	Group C
Surface Scratches	35 (25.9%)	10 (7.4%)	5 (3.7%)
Enamel Chipping	10 (7.4%)	25 (18.5%)	0 (0.0%)
Dentin Exposure	5 (3.7%)	20 (14.8%)	0 (0.0%)
No Damage	20 (14.8%)	0 (0.0%)	75 (55.6%)

DISCUSSION

Proximal surface damage during abutment preparation is a significant concern in fixed prosthodontics, as it can compromise the integrity of adjacent teeth and impact overall oral health. Iatrogenic factors, such as improper technique or the use of unsuitable instruments, can lead to unintended harm during the preparation process.[12,13]

The findings of our study align with previous research on iatrogenic proximal surface damage during abutment preparation, providing valuable comparisons and contrasts with the literature. Abdulwahhab *et al*. (2014) reported nearly 98% of examined teeth surfaces adjacent to crown-prepared teeth were proximally injured, with abrasion being the most common type of damage (58.7%).[14]

Khan *et al*. (2021) observed 71% proximal surface damage, with 39% visible under a magnifying glass and 11% to the naked eye. Their study emphasized the influence of the practitioner's experience, noting that house officers caused the most damage. Our results, particularly for the high-speed carbide bur (Group B) with a 60% damage rate, similarly suggest that specific techniques may pose a higher risk of injury, possibly exacerbated by the skill level of the practitioner. However, the damage was significantly lower (15%) when the guided preparation technique was employed, underscoring the value of protective measures.[15] Basudan *et al*. (2021) also highlighted high rates of iatrogenic damage during restorative procedures, emphasizing the role of hypersensitivity and rough materials in inducing injury. These findings mirror our study's observation of enamel chipping and dentin exposure in specimens prepared with the high-speed carbide bur. Our study contributes additional evidence supporting the need for improved techniques, as demonstrated by the guided preparation method's ability to limit damage.[16]

In comparison to Badar *et al*. (2019), who reported a high prevalence of damage to mesial (78%) and distal (60.6%) surfaces, with more severe damage observed in mandibular teeth, our study found that 60% of the high-speed carbide bur specimens showed severe damage.[17] Similarly, our study, in line with the findings of Harish *et al*. (2015) and SBE *et al*. (2023), demonstrated that the use

of a guided preparation technique with protective strips reduced damage to just 15% of specimens, confirming that protective measures significantly mitigate the risk of injury. These studies emphasized the importance of using protective barriers to maintain tooth integrity during restorative procedures, reinforcing the conclusion that proper technique selection plays a crucial role in minimizing iatrogenic damage. The consistent results across different studies highlight the effectiveness of protective strategies in clinical practice.[18,19] Milic *et al*. (2015) found that iatrogenic damage was present on 74% of approximal surfaces without protection, dropping to 50% and 46% when matrix bands and wedges were used.[20]

CONCLUSION

The choice of abutment preparation technique significantly affects the risk of iatrogenic damage to adjacent tooth surfaces. The guided preparation technique proved to be the most effective in minimizing such damage.

LIMITATIONS

This not differentiating between maxillary and mandibular teeth

SUGGESTIONS / RECOMMENDATIONS

Studies at larger sample should be conducted in future on this topic.

CONFLICT OF INTEREST / DISCLOSURE

None

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