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ORIGINAL RESEARCH

Comparison of the Efficacy of Three Different Instruments in the Removal of Amalgam Overhang: An *In Vitro* Study

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ABSTRACT

Aim: Overhang is the extension of restorative material beyond the cavity preparation. It changes sulcus microflora into organisms conducive to chronic periodontitis. After overhang removal the gingival index and microflora return to a healthy state. This can also improve access for dental plaque removal. The aim of this study was to compare the efficacy of three different instruments in association with amalgam overhang removal.

Materials and methods: One hundred thirty-five intact premolars were selected. The teeth were restored with amalgam such that restorations had 1 mm overhangs. Overhangs were removed employing three different instruments in three groups: sickle scaler, ultrasonic scaler, and diamond flame bur. A stereomicroscope was utilized to evaluate both the level of smoothness in the restored area, tooth damage and probable gaps. The data were analyzed using post hoc and Chi-square.

Results: The minimum and maximum time of removal were respectively obtained by ultrasonic scaler and sickle scaler, which was statistically significant (p <0.0001). Also, smoothness of the restored area in the sickle scaler group was significantly less than the other methods (p <0.0001).The percentage of tooth damage in the diamond flame bur group was significantly greater than the others (p <0.0001). The data concerning gap size showed no significant difference.

Conclusion: Ultrasonic scaler causes no significant damage to the tooth during an overhang removal procedure. In addition, it offers an acceptable level of surface smoothness in restorations and decreases the required time for overhang removal.

Clinical significance: Ultrasonic scaler can be recommended as an effective instrument for amalgam overhang removal.

Keywords: Amalgam, Flame bur, Overhang removal, Sickle scaler, Ultrasonic scaler.

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INTRODUCTION

Despite advancements in resin-based composite (RBC) technology, amalgam restoration is still in use as one of the common restorative treatment materials. The initial low cost as well as the long-term cost-effectiveness of this material in posterior restoration account for its frequent use in dental practice.[1,2]

The overhang is the extension of the restorative material beyond the cavity preparation.[3] It makes certain alterations to the oral environment, disturbing the balance between normal bacterial flora and pathogens, which in turn creates a risk factor for periodontal diseases.[1] Overhanging restorations pose a significant concern with an estimated prevalence of up to 76%.[2] Several studies have shown that attachment loss and inflammation is higher in teeth with overhanging dental restorations than those without.[2] Overhanging restorations exaggerate these inflammatory responses by increasing the retentive capacity of bacterial plaque, resulting in the destruction of surrounding structures.[4-6] Proximal overhangs not only cause increased accumulation of plaque; they also reduce the access of proximal cleaning devices (e.g., tooth sticks and interdental toothbrushes.[7,8]

The overhang can also damage both biologic width and dental embrasure. Observations reveal that restorations with subgingival margins lead to histological and clinical inflammation, along with the increased gingival fluid flow. When a restoration with overhang is modified to achieve a properly-fitted restoration, the gingival index and microflora tend to return to a healthy state. On account of the abovementioned issues, overhang removal can considerably improve periodontal health by preparing access for better plaque removal. Therefore, it is an important part of the initial phase of periodontal treatment.[9]

Generally, if the amalgam restoration with an overhang is grossly defective (that is, it involves new caries or is inaccessible for repair), replacement of the defective restoration is considered the best approach. However, if the overall amalgam restoration is basically adequate (no new caries is involved, and the overhang is minimal and accessible), less expensive alternatives, such as smoothing out the overhang or marginal repairs, are acceptable options.[10-12] Overhang removal is traditionally performed by removing the old restoration, primarily due to the limited access to interdental space for recontouring the restoration.[13] However, this method has been associated with some risks, including dental pulp damage, mercury vapor release, and unnecessary removal of dental tissue. Various methods have been tried in an attempt to accomplish a more conservative overhang removal; some of the experimented instruments include ultrasonic scaler, Sugarman file, curettes, amalgam knife, diamond finishing burs and surgical blade 12.[7]

Considering the fact that the available amount of studies evaluating the different methods for amalgam overhang removal is limited, the current research was designed to compare a number of conventional methods in this area. The findings may help to resolve the aforementioned problems and deliver savings of time and money to patients and dentists. So, this *in vitro* study investigates the effectiveness of three overhang removal instruments, namely: sickle scaler, ultrasonic scaler, and flame-shaped diamond bur.

MATERIALS AND METHODS

In this *in vitro* comparative study, 135 intact, caries-free first or second premolars were selected, all of which had been extracted because of orthodontic treatment. The remaining soft tissues were removed using an ultrasonic Piezo scaler, and the teeth were stored in distilled water. They were fixed in plaster casts in the following manner: first, a chromogel alginate impression (Marlik Dental, Iran) was prepared according to the dentiform model, and then the first or second premolar tooth was placed in the impression. In order to simulate the gingival tissue, polywax (Bilkim Chemical, Izmir, Turkey) was placed around the teeth. This was followed by performing the molding stage. Next, proximo-occlusal cavity (box-only type) was prepared with a 008 diamond Fissure bur by an operator using air and water coolant. These cavities were made in equal dimensions, with occlusogingival height of 4 mm. The buccolingual extension of the gingival and occlusal parts of the box was 3 mm and 2 mm, respectively.

To ensure similar amalgam overhangs with an equal dimension of 1mm, the teeth were removed from the casts and LLIS composites (FGM, Joinville, Brazil) were placed around the cavities, with a diameter of 1 mm and distance of 1 mm from all margins (Figs 1 and 2). This procedure was performed using a bonding agent (FGM, Goinville, SC, Brazil) and without acid etching for ease of removal.

In the next stage, the teeth were put back into the casts, and GK-110 amalgam (AT&M, Beijing, China) was placed in cavities using Tofflemire matrix band. The amalgam fillings were then packed vertically and laterally with

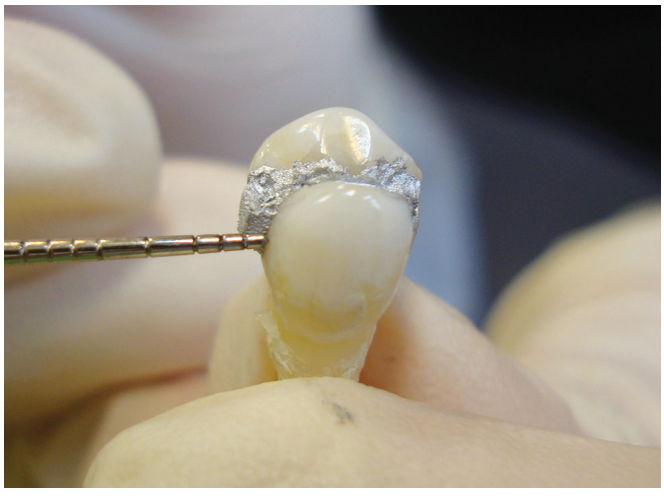


Fig. 1: Composite barrier was placed around the cavity

Fig. 2: Similar amalgam overhangs with an equal dimension of 1 mm

a dental condenser (Sialkot, Pakistan). Once the filling procedure was complete, the composites, which had been placed therein during the previous phase, were removed. According to the instructions of the amalgam manufacturer, setting time and carving time were 9 and 12 minutes, respectively. The teeth were ready for overhang removal 30 to 35 minutes after the filling. At this point, the teeth were randomly divided into three groups of 45 each.

- *Group 1:* Overhang removal was performed with D&P sickle scaler, model U15/30 (Dental Devices, Sialkot, Pakistan).
- *Group 2:* Overhang removal was performed with ultrasonic Piezo scaler, DTE, model V2 (Woodpecker, China) and PD1 tip.
- *Group 3:* Overhang removal was performed with flame-shaped diamond bur (D&Z, Kalletal, Germany).

The movement direction in all three methods was on edge, from gingival toward the occlusal surface. The maximum time required for overhang removal using an ultrasonic scaler and flame-shaped diamond bur was 3 minutes. As for sickle scaler, however, it was 15 minutes.[14]

Then, an explorer was used to evaluate the overhang removal efficacy, which was defined as follows:

- *Score 0:* Complete overhang removal
- *Score 1:* Amalgam remaining in cavosurface

Afterward, the operation area was photographed with a SONY camera; model DSC-W570/16.1 M.P (Tokyo, Japan). A stereo microscope (model: LX-4 SZX7, Olympus, JAPAN) with a magnification of ×10 was used to conduct a more accurate evaluation of the samples in terms of surface smoothness, tooth damage, the gap in the tooth and restoration interface. These photos were analyzed using the software, "Image J" (Research Service Branch, National Institute of Mental Health, Bethesda, Maryland, USA).[14] All stages were conducted by a single operator who was blind to the study groups to avoid confounding factors. Statistical package for the social sciences (SPSS) statistical software, version 21 (IBM, Armonk, USA), and post hoc and Chi-square test were used for statistical analysis. A *p* value of less than 0.05 was considered significant.

Table 1: Pairwise comparison of overhang removal time per second for each method

p	*Std. error*	*Mean difference (I-J)*	*Three method (I)*	*Three method (J)*
0.0173	9.3	25.8	Flame shape diamond	Sickle scaler
0.0001	9.3	90.5	Ultrasonic scaler	
0.0001	9.3	64.7	Ultra sonic scaler	Flame shape diamond bur

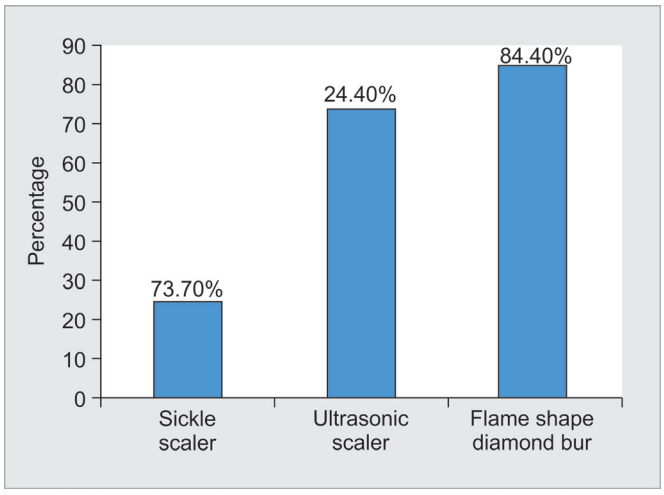
RESULTS

This study comprised three groups of 45 each. All three methods (sickle scaler, ultrasonic scaler, and flame-shaped diamond bur) resulted in complete overhang removal.

A comparative review of the overhang removal time in three groups revealed that mean and standard deviation values corresponding to sickle scaler, flame-shaped diamond bur, and ultrasonic scaler groups were 143.7 ± 58.8, 117.8 ± 46.3 and 53.2 ± 16 seconds, respectively, which was statistically significant (p <0.0001). Post hoc test was used for pairwise comparison of the removal time between the experimented methods which is presented in Table 1.

As far as the frequency distribution of restoration surface smoothness in the three groups was concerned, the resultant percentages pertinent to the sickle scaler, flame-shaped diamond bur, and ultrasonic scaler were 24.4%, 84.4%, and 73.3%, respectively (p <0.0001). As shown in Graph 1, the flame-shaped diamond bur method achieved a significantly higher percentage of restoration surface smoothness in comparison with the sickle scaler (p <0.0001) (Figs 3 to 5). A similar comparison between the flame-shaped diamond bur approach and the ultrasonic scaler showed no significant difference (p = 0.197). However, the sickle scaler method delivered a significantly lower percentage compared to the ultrasonic scaler (p <0.0001).

Comparison of the amount of tooth damage between the three methods is presented in Graph 2. Accordingly, the sickle scaler and flame-shaped diamond bur methods caused the lowest and highest percentages of tooth damage, respectively. The level of tooth damage was significantly higher in the flame-shaped diamond bur treatment than the other methods (p <0.0001). No significant difference was observed between the sickle scaler and ultrasonic scaler approaches (p <0.308).



Graph 1: Restoration surface smoothness for each instrument

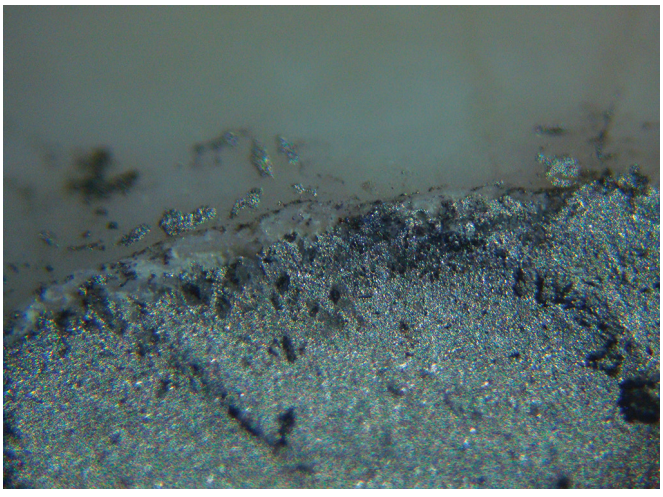


Fig. 3: Microscopic view (10X magnification) of amalgam surface after overhang removal by the sickle scaler

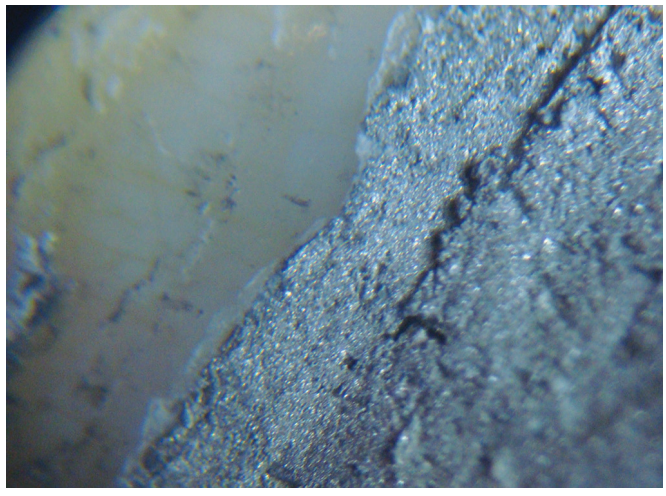


Fig. 4: Microscopic view (10X magnification) of amalgam surface after overhang removal by ultrasonic scaler

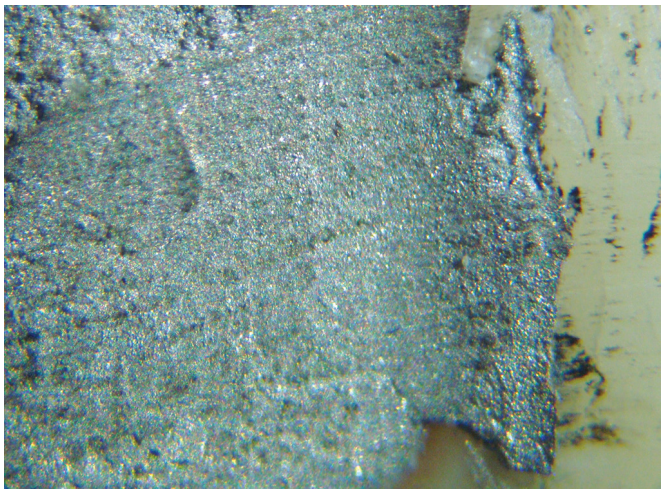
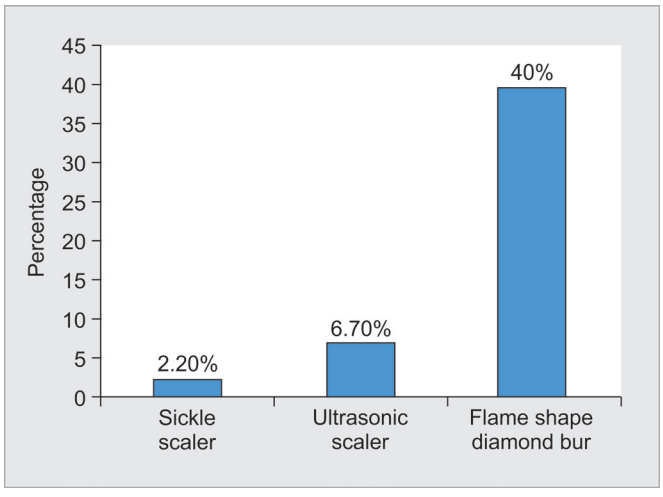


Fig. 5: Microscopic view (10X magnification) of amalgam surface after overhang removal by flame shape diamond bur



Graph 2: Comparison of tooth damage for each instrument

The gaps in tooth-restoration interfaces were 73.3%, 71.1%, and 75.6% for sickle scaler, ultrasonic scaler, and flame-shaped diamond bur methods, respectively ($p = 0.969$).

DISCUSSION

The most common procedural concern in class II amalgam restorations is amalgam overhang. The prevalence of this phenomenon could be as high as 76%.[2] The main cause of overhanging restoration has often been described as improper restoration methods, such as neglecting the use of matrix band and wedge. Another reason has been cited to be the morphologic variation in the cervical aspect of teeth, which can impede the appropriate placement of the matrix band and wedge in complete conformity to gingival cavo-margin.[15,16]

There is no doubt that bacterial plaque causes gingival inflammation. Yet, many predisposing factors, such as overhang, can aggravate the condition. Evidence exists that overhanging restorations are associated with an increased attachment loss, deeper periodontal pockets, and overhanging margins are usually associated with plaque accumulation and contribute to show the greater occurrence of secondary caries and microleakage.[9]

In the present experiment, three conservative overhang removal instruments (sickle scaler, ultrasonic scaler, and flame-shaped diamond bur) were applied to remove overhangs. All of them proved capable of complete overhang removal. Lim and Ong.[17] used a flame-shaped diamond bur to remove amalgam overhangs and reported this method as an effective and efficient choice for the purpose. Also, Spinks et al.[18] Vale and Caffesse.[19] showed that the application of sickle scaler and ultrasonic scaler were both efficient.

In the study performed by Lim and Ong.,[17] the shortest removal time was achieved with a diamond bur and the longest with the EVA system. Spinks et al.[18] also suggested that the fastest and easiest removal method was the EVA system while the slowest and the most difficult removal option was the use of curettes hand tool. The findings of the current study showed that all of the three

hand tools involved were eventually capable of overhang removal, but ultrasonic scaler was the fastest instrument. Accordingly, the operator experienced the least amount of fatigue when using ultrasonic scaler. In contrast, utilizing the sickle scaler meant a significantly higher level of fatigue for the operator because of its longer overhang removal time. The flame-shaped diamond bur method was more exhausting than the ultrasonic scaler approach and required more accuracy. However, the former was less exhausting than the sickle scaler method.

A major risk with bulky amalgam overhangs is that they may fracture unpredictably and create irregular projections or voids in restorations. With respect to restoration surface smoothness after overhang removal, this study showed that the flame-shaped diamond bur and ultrasonic scaler methods produced relatively smooth surfaces, but the sickle scaler treatment created the roughest restoration surfaces.

In this study, the use of sickle scaler, unlike other methods in which overhang removal is controlled, caused amalgam ditch on weak and thin areas (mostly at the cavity margin), where plaque accumulation typically appears afterward. Uncontrolled fracture of the overhang could render the restoration under-contoured, so manual dexterity and the control of force are of the utmost importance when using these instruments. However, creating such areas is easier, and their amalgam removal is performed in less time. Yet, the operator had to complete the procedure by applying filing and polishing strips on the overhangs. Also, polishing with a rubber cup and pumice had to be performed to minimize roughness and prevent plaque accumulation.

In this process, damage to the adjacent tooth structure and soft tissue is an expected occurrence. Hand tools (sickle scaler and curettes) caused the minimum tooth damage in the current study, which was similar to the findings of Molina et al.[14] and Spinks et al.[18] Chan et al. reported that flame-shaped diamond bur resulted in a significantly higher percentage of tooth damage compared to the other two experimented methods, indicating that burs are inherently rigid instruments which can access both the gingival and interproximal areas.[20]

An evident property in all of the study groups was a deficiency in restoration margins, in the form of gap and void. This was possibly related to amalgam overhang removals and could be linked to a number of factors including inappropriate placement of matrix band, inappropriate use of wedge, insufficient condensation pressure, and dimensional changes of amalgam, all of which affect the conformity of amalgam to the cavity wall. This can lead to breakage of the enamel or amalgam.[15]

Various studies have revealed that plaque accumulation is a potential phenomenon in these areas.[17-22] Due to inadequate accessibility in these areas, the existing plaque may be resistant to even the most accurate oral-hygiene methods performed by the patient or dentist, which will ultimately necessitate restoration replacement.

However, the main concern with regard to subgingival overhangs tends to be the dentist's limited vision and access, which may result in accidental damage to the tissues around the tooth during the overhang removal procedure. In these circumstances, the dentist should first examine the restoration quality as well as the overhang position, and then decide whether replacement of the restoration is necessary.

In the present study, stereomicroscope and software analysis was employed to evaluate restoration surface smoothness. However, it is recommended to use a scanning electron microscope (SEM) in further studies. In addition, the results of this study should be carefully interpreted. Further investigation of the findings in a clinical setting is advisable.

CONCLUSION

Despite the limitations of this in vitro study, the results indicated that the application of sickle scaler seems to cause the lowest amount of tooth damage in the process of overhang removal. Nevertheless, it produces a significant amount of breakage on the amalgam surface and requires the longest removal time. As for the flame-shaped diamond bur approach, it appears to result in the highest amount of tooth damage but delivers an acceptable level of restoration surface smoothness and removal time. It was observed that the ultrasonic scaler method involved no significant tooth damage in the process of overhang removal. Additionally, it tends to offer the shortest removal time and an acceptable measure of restoration surface smoothness. Therefore, this method can be highly recommended as an effective choice of treatment in clinical settings.

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