A COMPARATIVE EVALUATION OF FUNCTIONAL EFFICIENCY OF DIAMOND BUR USED WITH DISTILLED WATER, DISTILLED WATER MODIFIED BY ADDITION OF MOUTHWASH AND LACTATED RINGER SOLUTION AS COOLANTS- AN IN-VITRO STUDY

Tushar Vithalrao Bhagat, Ram U. Thombare

ABSTRACT

Background: Several studies conducted to improve cutting efficiency of dental burs but none of that have tried to modify coolant used during cutting. Aims and Objectives: To compare the cutting efficiency of diamond bur when using with modified coolants such as mouthwash and lactated ringer solution. Method and Material: Cutting operation was performed on Ivorene teeth on specially designed stand, using modifying coolants. Control group was plain distilled water, other group were distilled water modified with mouthwash and lactated ringer solution. The time taken to for each cut was calculated and the data obtained are statistically analyzed by using One-way ANOVA, Unpaired t-test and Dunnett D test along with critical evaluation of SEM photograph of each bur. Result: Distilled H2O modified with Chlorhexidine mouthwash was superior over Lactated ringer which was graded second, whereas Distilled H2O coolant was third for completing the cutting operation. All findings have been also supported by the observation of the photomicrograph obtained by SEM of Diamond burs used in this study.

Key Words: Coolant; SEM; Chlorhexidine Mouthwash; Ringer Lactate Solution

Introduction

The effective use of rotary instruments with Carbide and Diamond burs for the removal of tough enamel was done with a speed of about 10,000 rpm. As the speed increases, the cutting efficiency of Steel burs was reported to be less. In 1947, Carbide burs were introduced in Dentistry having functional efficiency much better than Steel burs. The German industry presented better quality bur made by using Diamond particles. The Diamond burs have proved its excellent cutting efficiency as compared to Steel and Carbide burs and also proved to have longer life.

Application of excessive pressure to increase the cutting efficiency with low speed results in heat generation and cause damage to pulp tissue when used without a coolant. The most commonly used coolant in Dentistry is distilled water, which is directed to the site in the form of spray, to minimize heat generation and thereby reducing the damage to pulp and also to eliminate the effect of clogging to certain extend. Thus the aim of the present study was a) to evaluate the effect of Distilled water coolant modified by addition of Mouthwash on the functional efficiency of diamond bur, b) to evaluate the effect of Lactated ringer solution used as coolant on the functional efficiency of Diamond bur and c) to compare the effectiveness of above three coolants on the functional efficiency of Diamond bur.

Materials and Methods

1. An Apparatus-cum-Stand was Specially Designed for holding Ivorene Tooth at desired position in relation with the Contra-angle hand piece so that the cutting operation on tooth can be performed as per the standard protocol decided for this study to judge functional efficiency of diamond bur (Fig. 1).
completely cut the groove throughout the thickness of the tooth, the hand piece head comes in contact with Time Sensor, and the watch will stop automatically. This provides correct readings about the time required to complete the cutting operation on tooth (sectioning). Digital Stopwatch was attached to other end of Time Sensor through wire. e) A Load (W) of 147.5 gm [0.9 kilo Newton at the bur tip] was applied over the hand piece during cutting operation to simulate the pressure effect at the time of cutting.

Following adjustments were carried out:

1. The rate of flow of coolant was adjusted at 22 milliliter / minute by controlling flow rate knob of dental chair. The Air-rotor rpm was adjusted at 1, 60,000 revolution per minute (rpm) by operating air pressure regulator knob.

2. Coolants used in the study: Distilled Water (DW), Distilled water Modified with addition of Mouthwash (DW+MW), Lactated Ringer solution (RL).

3. Grouping of the samples as shown in table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Coolants Used</th>
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<tbody>
<tr>
<td>Group 1 (Control)</td>
<td>Distilled water(DW)</td>
</tr>
<tr>
<td>Group 2</td>
<td>Distilled water modified by addition of Mouthwash(DW+MW)</td>
</tr>
<tr>
<td>Group 3</td>
<td>Lactated ringer solution (RL)</td>
</tr>
</tbody>
</table>

Table. 1: Grouping of sample

4. Marking “cut line” on ivorene tooth: The root portion of Ivorene tooth was made flat on buccal and palatal aspects. This flattening of root surfaces was done to stabilize the tooth in the Tooth Holding Clamp. This has eliminated movement of tooth during cutting operation. A horizontal line was marked on labial surface of the tooth, 5 mm away from incisal edge towards the cervical region (Fig. 2). Two vertical lines were marked on labial aspect of tooth keeping 2.5 mm distances between these lines and sufficient tooth material on mesial and distal aspects of the tooth should be there after cuts.

5. Procedure followed for cutting the groves on tooth (sectioning of tooth): In this study, the standard regimen was followed to maintain uniformity for all cutting operation. The Ivorene teeth were used in this study for cutting operation. The Ivorene tooth was screwed to Tooth Holding Plate. Then the tooth holding plate was fixed with Tooth Holding Clamp (Fig 2). The clamp was then fixed with Vertical Arm. The position of clamp on Vertical Arm in relation with hand piece was adjusted by operating Two way joint (U). The Hand piece was kept parallel with the horizon. The 70% bur–to-tooth contact was adjusted on labial surface of tooth. The bur was placed on the vertical marking on the tooth (Fig. 3).

Approximately 4mm distance was kept from the head of hand piece with Time sensor. After the completion of cutting operation, the hand piece falls down by touching the Time sensor. This contact by the head of hand piece with time sensor results in stoppage of Digital stopwatch automatically. This has given error free recording of the time required to complete cutting operation performed on Ivorene tooth.

Following adjustments were made before start of cutting operation as a protocol for obtaining error free readings:

1. Adjustment for “rpm” , 2. Adjustment of “coolant flow rate, 3. Stainless steel wire loop having weights attached to be position in notch carved on hand piece, 4. Digital Stopwatch to be set before the start of cutting operation.

After making above adjustments, the cutting operations were performed at the vertical markings made on samples of all group teeth. Two cuts were made on each sample throughout the thickness of the Ivorene tooth. The time required for each cut was then recorded through Digital Stopwatch - Sensor System and tabulated as results. Five such cuts were given by each bur used in this study. Such 13 samples (teeth) were used for each group.

Figure 3: 70 % bur to tooth contact. Figure 4: Cutting operation performed on the vertical marking made on ivorene tooth.

Results

The time factor was taken into account for counting efficiency and comparative analysis of the results of all three coolants. The values with minimum, maximum and average time required for cutting the tooth for all 5 cuts used in the study with distilled water, modified mouth wash and lactated ringer solution as coolant respectively (Table. 2, 3, 4). The results so obtained are statistically analyzed by using One-way ANOVA and Dunnett D test. Inference of One way ANOVA showed mean value of time required for cutting the tooth shows significant variation.

Multiple Dunnett ‘t’ (2 sided) test shows that the difference between DW+MW & DW, RL are found to be statistically significant. The Student ‘t’ test shows that the difference between DW+MW RL is found to be statistically significant (p<0.05).
The results of this study are in agreement with the conclusions of earlier investigations. On critical evaluation of the data obtained, it was noticed that, the distilled water coolant modified by addition of Chlorhexidine mouthwash increases the functional efficiency of diamond bur when compared with plain Distilled water and Lactated ringer solution used as coolant. The cutting efficiency of bur decreases with the increasing number of cutting operations performed by same bur. Thus underlines the need of changing the bur to avoid heat generation and thereby avoiding trauma to the pulp tissue.

**Discussion**

The most desired objectives in any dental treatment was to improve and/or maintain the overall oral health and hygiene status of the patient and to provide effective mechanical repair or replacement of the part of masticatory apparatus so as to restore the lost or impaired functions. The decay or fracture of tooth, missing teeth, congenital or acquired deformities needs either restoration of the part affected or replacement by prosthesis. For making these restorations or prosthesis, tooth modifications or definitive preparations were required which demand removal of hard tooth material to shape the preparation without causing damage to vital structure vs. pulp tissue.

The plugging of the bur with debris, did not allow it to cut tooth material efficiently, and requires more time to reduce tooth. To overcome this problem it was necessary to clean the bur to avoid clogging. For this purpose, coolant at the site of operation was advocated. Unfortunately very less information is available in literature on this aspect. The most common coolant used in past was Air or Air-Water spray. Use of Distilled water as coolant is very common and also economic.

In this study, the Distilled water was modified by adding mouthwash in the ratio 5:1 and the mixture was used as coolant and Lactated ringer solution was also used as coolant. The comparison was made with Distilled water coolant. All three coolants were used with diamond bur and functional efficiency of the bur was evaluated. The time factor was taken into account for counting efficiency and comparative analysis of the results of all three coolants was done. The cutting medium used was to judge cutting efficiency of diamond bur. In the earlier investigations, Macroglass ceramic sheet were also used to evaluate functional efficiency of bur.

To simulate the ‘tooth-to-bur’ contact relationship during cutting operation in this study, a specially designed ‘Apparatus-cum-Stand’ was fabricated. This stand has proved its utility in this in-vitro study. The design is simple and fabrication was done using routinely available materials thus minimized cost. The cutting operations performed in this study were strictly adhered to the pre-decided protocol for standardization. The weight of 147.5gm was applied on hand piece to transfer necessary pressure at the bur during reduction of tooth. The spray of coolant was directed at the sight of operation and sufficient pressure at the bur during reduction of tooth. The spray of coolant was directed at the sight of operation and “Time Sensor-Stopwatch” system was used to record the time taken for each cutting operation. This system has proved to be an acceptable method of recording accurate time required for performing cutting operation by using Diamond bur. The coolants used in this study have proved their usefulness in fastening the cutting of Ivorene tooth. Amongst them, the Distilled water modified with addition of Chlorhexidine mouthwash established its superiority over other two. Lactated ringer solution used as coolant is graded second in order of effect, whereas Distilled water coolant consumed more time for completing the cutting operation. The results of this study are in agreement with the conclusions of earlier investigations.

While tooth preparation, the tooth material is removed from tooth surface and these particles get caught between the abrasive particles of the Diamond bur. Thus the ‘Effective cutting edges’ are reduced in quantity and quality. This is referred as “Clogging” The ability of Distilled water alone to remove the debris with bur is proved to be minimum whereas by addition of Chlorhexidine mouthwash cleans the debris more effectively and thus it has established its superiority on this count. The cutting rate increases due to presence of surface active agents-compound in mouthwash which reduces interfacial tension-by irrigating dental hand piece’s and thus enhance
cutting efficiency. The values obtained for cutting operations were statistically analyzed. Significant difference was found between Distilled water, Distilled water modified with mouthwash and Lactated Ringer solution.

Conclusion

In conclusion the distilled water coolant modified by addition of Chlorhexidine mouthwash increases the functional efficiency of diamond bur when compared with plain Distilled water and Lactated ringer solution which stand second. The Time Sensor Stop watch system used for recording time interval proved its utility.

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