Evaluation of single crowns using USPHS criteria during cementation - A retrospective study

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ABSTRACT

The modern era is seeing an incline in dental health issues namely dental caries, missing teeth, etc. causing an increased use of prosthetics to replace the function of such teeth or provide esthetics. This has led to various studies in this field to improve the quality and lifespan of the crowns. An important aspect of this is to consider the cementation process and luting material used, which are crucial in determining the result. A retrospective study was done on patients reporting to Saveetha Dental College and Hospitals. A sample size of 1055 was obtained and data tabulated using the Excel sheet. SPSS software was used to analyze the data statistically. Chi-square test was done to evaluate the association between tooth type and cement used, USPHS scores for adaptation, colour match, marginal discoloration and surface roughness. The study revealed that GIC was the most common luting material used which was statistically significant and lower molars were the most involved sites for cementation. The most common USPHS score for adaptation, marginal discoloration and surface roughness for all types of tooth was Score 0. For color match, the most common USPHS score was Score 1.

INTRODUCTION

The last few decades have seen an increase in oral health issues, of which dental caries and periodontal diseases top the list followed by tooth loss (DiNiccolantonio and O’Keefe, 2018; Nasim and Nandakumar, 2018). Dental caries involving the pulp, damaged teeth due to trauma, non-vital teeth, attrition, etc. all have a common treatment plan which is the insertion of a prosthesis. Dental crowns source to restore the esthetics and functions of the tooth that was affected thus helping to improve the quality of life (Nair et al., 2018; Teja and Ramesh, 2019).

Dental crowns play an important role, and in today’s era of increasing dental issues, its importance has become prime. Thus numerous studies to improve the quality and life span of crowns have been conducted over the years (Ramesh et al., 2018; Janani et al., 2020). These studies have led to modern design and increased life span of the crowns, the other aspect to increasing the quality of the dental crowns depends on the luting cement and the tooth
preparation.
The average lifespan of a dental crown is anywhere between 15 years up to 25 years if maintained well (Noor, 2016). Some factors that prolong its lifespan are quality of crown material used, luting cement, crown design, tooth vitality, tooth preparation, etc (Ramamoorthy et al., 2015; Kumar and Antony, 2018; Ravinthar and Jayalakshmi, 2018). All the aforementioned factors play an important role during the cementation of the dental crown (Siddique, 2019). Several studies stress about cementation as a crucial step in the insertion of a crown. Proper cementation ensures both functional and aesthetic aspects of the crown ensuring good marginal fit, color match, microleakage prevention, etc. The US Public Health Service or USPHS in short have proposed guidelines to ensure proper cementation. Presently the modified USPHS criteria are used to assess the crowns for the quality of cementation. This criterion includes factors like adaptation, color match, surface roughness, and marginal discoloration (which is indicative of secondary caries). Each of the 4 criteria is scored ranging from 0 to 4 with 0 being the most favorable score.

Another aspect to consider here is the luting cement being used. Over the years dentists transitioned from zinc oxide-based types of cement to GIC, resin-modified cement to resin cement and all three are still in use based on specific requirements. Some of the most used cement include GIC, RM-GIC and Panavia (Nasim et al., 2018). Studies suggest GIC has good properties and is one of the most commonly used cement, however, studies also show growing use of Panavia, especially with zirconia crowns. The cement used affects the final retention and seal of the crown and is thus crucial to sustaining a long term performance of a crown.

Owing to the importance of luting material used during cementation (Rajendran et al., 2019), it is pivotal to understand the current trends in luting cement and its association with the quality of cementation. This provides comprehensive knowledge and rationale behind current trends, thus this study aims at evaluating the cementation of single crowns using the USPHS criteria.

**MATERIALS AND METHODS**

This study has been thoroughly planned for methodology. The study involves a retrospective approach through access to patient reports in Saveetha Dental Hospital, before beginning the study ethical approval was obtained (Ethical approval number SDC/SIHEC/2020/DIASDATA/0619-0320) and permission to access the reports were sought. The hospital online patients database was used to assess patient reports. Sampling was done using a convenience sampling method.

The advantage of using a hospital database gives access to a larger data set to work on and reduces the hassle and time to independently evaluate each patient for the criteria needed, secondly the ease of access of the data greatly reduces the complexity of the process.

However, retrospectively conducting the study has its downfalls. The study population is most often people living in close proximity to the hospital, this drastically limits the sample diversity, causing a sample population of similar socio-economic status or location, which may in turn affect the study outcome. Also, this may not depict the general population correctly.

Patient records specific to single crowns and its USPHS scores were obtained, this data was further verified using patient reports and clinical pictures. All incomplete data were excluded from the study to reduce bias. Initially, a sample size of 1638 was noted, however, after the exclusion of incomplete data a final total of 1055 was obtained of which 47% were females and 53% were males ranging from ages 18 to 75 years. The data was collected and tabulated on an Excel sheet and SPSS software was used to analyze the data.

Chi-square test was done to evaluate the association between tooth type and cement used, USPHS scores for adaptation, colour match, marginal discoloration and surface roughness. P-value <0.05 was considered statistically significant.

**RESULTS AND DISCUSSION**

This study was done to analyze trends in cementation associated with luting cement used, and look at the commonly used cement for the study population being assessed. The findings of the study can be summarized into 5 main points that have been depicted as graphs (Graphs 1, 2, 3, 4 and 5). Study revealed GIC was the most commonly used luting cement (59%) as seen from Graph 1. Graphs 2, 3, 4 and 5 shows the USPHS scores for individual criteria for the various teeth sites. It can be summarized that all criteria namely adaptation, marginal discolouration, color match, and surface roughness, show 0 as the most common score with an exception in the color match which shows both score 0 and 1 to be common. Table 1 depicts the USPHS score.

The present study revealed GIC was the most commonly used luting cement (59%) followed by Panavia and RM-GIC at 25% and 15% respectively.
Table 1: Modified USPHS criteria

<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptation</td>
<td>0</td>
<td>Smooth margin</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>All margins closed, or possess minor voids or defects (enamel exposed)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Obvious crevice at margin, dentin or base exposed</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Debonded from one end</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Debonded from both ends</td>
</tr>
<tr>
<td>Color match</td>
<td>0</td>
<td>Very good color match</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Good color match</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Slight mismatch in color or shade</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Obvious mismatch outside the normal range</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Gross mismatch</td>
</tr>
<tr>
<td>Marginal discoloration</td>
<td>0</td>
<td>No discoloration evident</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Slight staining, can be polished away</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Obvious staining, cannot be polished away</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Gross staining</td>
</tr>
<tr>
<td>Surface roughness</td>
<td>0</td>
<td>Smooth surface</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Slightly rough or pitted</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Rough, cannot be refinished</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Surface deeply pitted, irregular grooves</td>
</tr>
</tbody>
</table>

Graph 1: Represents the association between teeth site and luting cement used in cementation

Graph 2: Represents the association between teeth site and adaptation score in the USPHS criteria

Graph 3: Represents the association between teeth site and marginal discoloration score in the USPHS criteria

Graph 4: Represents the association between the teeth site and the color match score in the USPHS criteria
GIC being highly biocompatible and having good mechanical properties suggests a reason for the widespread use of this cement. A study by Bhat-tacharya et al. (2017) revealed GIC was the most commonly used luting cement. However certain studies show increasing popularity of resin cement in recent times, due to its increased strength and biomechanical properties (Ganapathy, 2016).

Looking at the site most involved or site undergoing frequent cementation as seen in Graph 2, the lower molars have the highest frequency at 31% followed by upper anteriors at 22.5%. This is possibly due to the fact that upper anteriors being the most affected teeth when it comes to dental trauma and lower molars with dental caries (Manohar and Sharma, 2018; Jose et al., 2020). Studies by authors Mustafa D et al. and Rajakeerthi et al. suggest upper anterior and lower molar the most affected teeth respectively (Rajakeerthi and Nivedhitha, 2019). However studies also suggest upper molars to be more affected (Ramanathan and Solete, 2015) which does not agree with the present study.

USPHS criteria is a standardized method to clinically evaluate the clinical performance of direct and indirect dental restorations. This criteria was developed by Ryge in the 1970s and was developed based on amalgam restoration which was commonly used that time (Bayne and Schmalz, 2005). This criteria has been modified by many authors to adapt to the newer restorative materials that are being introduced. In our study, for evaluation of single crowns we have considered four criteria, namely adaptation, marginal discoloration, colour match and surface roughness. The scoring criteria for each parameter and its description is given in detail in Table 1.

In a prospective clinical trial, the above criteria will be used to assess the dental restorations at baseline, and the prescribed follow up periods of that particular trial. In our retrospective study, we have considered only the baseline scores of single crowns cemented in our institution. For all criteria, Score 0 represents the excellent score and the Score 1, 2, 3 or 4 represents the decreasing order of quality. Considering the USPHS score for the various teeth sites, it can be noted from Graphs 2, 3 and 4 that the score 0 is the most common in all sites for the following criteria: adaptation, marginal discoloration, and surface roughness. However, the color match does not follow this pattern, for color match score 1 is more common followed by score 0.

Both scores 0 and 1 show color match that’s desired (van Dijken and Pallesen, 2017) (0 - very good color match and 1- good color match). However score 1 is slightly higher than 0 and this could be attributed to the fact that shade matching is difficult to attain and requires various light adjustments to visualize proper shade (however both scores are of a high standard and clinically acceptable). Another reason could be due to the availability of the material with the desired shade. For CAD/CAM all-ceramic restorations, ceramic blocks have to be purchased for milling procedures. At certain times, particular shades of blocks may not be available. This could have been the challenge during the colour matching process.

This study was performed on limited sample size and may not depict the general population precisely. This retrospective study has considered only the baseline USPHS criteria for single crowns. Hence all the scores are excellent. Thus the future scope of the study is to conduct the study on a larger sample size prospectively to get a better understanding of the clinical performance of single crowns (Nallaswamy et al., 2019).

In Graph 1, X-axis represents teeth site and the Y-axis represents the frequency of the teeth by type of cement used namely GIC, Panavia and RM-GIC (depicted in yellow, amber and grey). Association between teeth site and luting cement was done using Chi-square test (Chi square value = 57.731, p-value = 0.000) and was found to be statistically significant. Out of the luting cements used, it was noted that GIC was the most commonly used at 59% followed by Panavia and RM-GIC at 25% and 16% respectively.

In Graph 2, X-axis represents the teeth site and the Y-axis represents the number of teeth by score. Association between teeth site and adaptation score was done using Chi-square test (Chi square value = 56.729, p value = 0.000) and was found to be statistically significant. The adaptation score of 0 which
represents smooth margins, was found to be most common at 75% (denoted by blue color) suggesting that a majority of the luted crowns have a superior adaptation score, followed by scores 1, 2, 3 at 24%, 0.01% and 0.003% respectively (denoted by red, green and orange colors respectively). In Graph 3, X axis represents the teeth site and the Y axis represents the number of teeth by score. Association between teeth site and marginal discoloration score was done using Chi-square test (Chi square value = 11.263, p value = 0.734) and was found to be statistically not significant (p>0.05). The marginal discoloration score of 0 which represent no discoloration, was found to be the most common score - 95.6% (denoted by violet), followed by scores 1, 2, 3 (denoted by purple, mauve and lavender colors respectively).

In Graph 4, X axis represents the teeth site and the Y axis represents the number of teeth by score. Association between teeth site and color match score was done using Chi-square test (Chi square value = 41.087, p value = 0.004) and was found to be statistically significant. The color match score of 1 representing good color match was found to be most common at 46% (denoted by oxford blue), followed by scores 0, 2, 3, 4 at 40%, 11% and 1% (denoted by blue, azure, steel blue and light blue colors respectively). This suggests that crowns in all teeth sites have clinically acceptable color match with a combined Score of 1 and 0 at 86%. In Graph 5, X axis represents the teeth site and the Y axis represents the number of teeth by score. Association between teeth site and surface roughness score was done using Chi-square test (Chi square value = 108.617, p value = 0.000) and was found to be statistically significant. The surface roughness score of 0 representing smooth surface, was found to be most common at 97% (denoted by dark green color) suggesting a majority of the crowns have a superior score in terms of surface roughness, followed by scores 1 and 2 respectively (denoted by green and mint colors respectively).

CONCLUSION
The present retrospective study revealed that GIC was the most popular luting cement material. It was also observed that the most common USPHS score was 0 except for the color match criteria, which had a score of 1 and 0. However these scores are within the acceptable range.

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Authors Contributions
First author Nauma Hafeez contributed towards the data collection, data analysis, and manuscript preparation. The second author Dr. Nivedhitha contributed towards the study design, key concepts, critical analysis, and review of the study. Third author Dr. Uma Maheswari contributed towards the manuscript revision and final approval.

Conflict of Interest
The authors declare that there is no conflict of interest for this study.

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