TOOTH RESTORATIVE MATERIALS AND PLAQUE RETENTION: A CLINICAL STUDY

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BDS LEVEL III
2014

A research proposal submitted in partial fulfillment of the degree of Bachelor Of Dental Surgery (BDS) of the University Of Nairobi.
DECLARATION

I JESSE SEMBENE OMUTAKHA MUTAKHA hereby declare that this is my original work and that it has not been submitted by any other person for research purposes or a degree in any other university or institution.

Date: 29/06/2014
Signed: [Signature]

SUPERVISORS' APPROVAL

We certify that this research project has been submitted with our approval as supervisors.

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DEFINITION OF TERMS
GIC – Glass Ionomer Cement

UoN - University Of Nairobi

NHANES III – Third National Health And Nutrition Examination Survey

BDS – Bachelor of Dental Surgery
ABSTRACT

Secondary caries is one of the main causes for failure of tooth restorations. Dental plaque is the main aetiological factor of dental caries. An understanding of the differences in plaque retention of different restorative materials would therefore help lengthen the life of tooth restorations in the oral cavity and improve patient satisfaction.

Objective: The aim of this study is to investigate the differences in plaque retention between some of the commonly used tooth restorative materials in Kenya.

Study design: The study will be a cross sectional study.

Study area: The study will be conducted at the University Of Nairobi Dental Hospital, Periodontology Clinic in Nairobi, the capital city of Kenya.

Study population: Adult patients between the ages of 18 and 65 seeking treatment at the UoN Dental Hospital, Periodontology Clinic.

Materials and methods: An intraoral examination shall be performed on a randomly selected sample of patients and the data collected recorded on a data collection form.

Data will be analyzed using the statistical package for social sciences (SPSS) version 16.0, Microsoft Office Excel 2007 and presented in form of tables, graphs and text.

Study benefits: The information from this study could be used to improve the oral health of patients with restorations, reduce the prevalence of secondary caries and prevalence of gingivitis in patients with restorations.
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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

Dental plaque is the main etiological factor in the pathogenesis of many diseases of the oral cavity and tissues. Some of these diseases include dental caries, perimplantitis, gingivitis and other periodontal diseases.

Dental plaque is defined as a diverse community of microorganisms embedded in an extracellular polymer matrix of bacterial origin and including host components. Bacterial colonization starts with the adhesion of early colonizers to the salivary pellicle on teeth as well as on dental materials within minutes after tooth cleaning.

Poor oral hygiene, and thus increased plaque retention, results in a higher predisposition to acquiring many of these oral diseases. It would therefore be of great clinical importance to understand plaque retention and the factors affecting it in order to prevent oral diseases in future.

Restorative dental materials consist of all synthetic components that can be used to repair or replace tooth structure. These include such items as noble and base metals, amalgam alloys, cements, resin composites, glass ionomers, ceramic, gypsum materials, casting investments, dental waxes, impression materials, denture base materials, and other materials used in restorative dental operations.

Some of the materials to be tested in this study are dental amalgam, resin composite, and GIC. Dental amalgam is an alloy of mercury, silver copper, and tin, which may also contain palladium, zinc, and other elements to improve handling characteristic and clinical performance.

Resin composite is a highly cross-linked material reinforced by a dispersion of amorphous silica, glass, crystalline, or organic resin filler particles and/or short fibers bonded to the matrix by a coupling agent. GIC refers to a group of materials based on the reaction of silicate glass powder and polyacrylic acid. The type used most commonly for restorations is resin modified GIC or hybrid ionomer where part of the polyacrylic acid is replaced with hydrophilic monomers.

These dental materials have different mechanical properties, chemical properties and surface characteristics even after final polishing. Of critical importance in plaque retention is their
surface characteristics, especially surface energy. Surface energy is defined as the increase in energy per unit area of surface\(^5\). Rough surfaces will promote plaque formation and maturation and high energy surfaces are known to collect more plaque, to bind plaque more strongly and to select specific bacteria\(^4\).

Bacterial colonization is an essential first step in the formation of dental plaque. An *in vitro* study done in 2007 concluded that the number of adherent bacterial cells was higher on titanium, gold and ceramic surfaces but lower on resin composite in comparison to enamel\(^5\). Another study showed that there is a correlation between materials’ glass content and bacterial vitality\(^1\). This shows that there is a significant difference in plaque retention of different restorative materials that is worth testing clinically.

Also, secondary caries has been widely considered the most common cause for restoration replacement regardless of restorative material type. Secondary caries, as defined by the Fédération Dentaire Internationale, is “a positively diagnosed carious lesion, which occurs at the margins of an already existing restoration”\(^6\). The primary aetiological factor of carious lesions is plaque. It can therefore be concluded that if the accumulation of dental plaque can be reduced then the incidence of caries, including secondary caries, can be reduced.

The aim of this study is to investigate the differences in plaque retention between some of the commonly used tooth restorative materials in Kenya.
1.2 LITERATURE REVIEW

In the past several studies have been conducted investigating the adherence and vitality of various species of bacteria to tooth restorative materials and enamel. In one such study the adherence and vitality of *Streptococcus sanguinis* to tooth restorative materials and enamel was tested in vitro in a flow chamber. This study attempted to recreate the oral environment by the use of a culture temperature within the normal range of body temperature, calibrating the flow chamber to a flow rate that corresponded to the physiological conditions of low shear in the oral cavity and collection of saliva from only one individual who was healthy, had no caries and was on no medications. However despite these efforts this study failed to properly recreate the conditions a tooth and/or restorative material would be subjected to in the oral cavity during function on a daily basis. Ordinarily a tooth and or restorative material would be subject to temperature changes, surface moisture changes, occlusal forces and a host of other variables that could significantly affect and alter the formation of dental plaque on their surfaces. This study also only compared titanium, gold, ceramic and composite, of which composite is the only material commonly used to restore teeth in Kenya. The study also failed to test dental amalgam which despite the current phase-down is still widely used by dentists in Kenya.

Another study determined that there are little surface roughness-related differences in bacterial adherence between different materials tested. However a different study conflictingly concluded that rough surfaces accumulate and retain more plaque, after several days harbor a more mature plaque, and that rough surfaces were more frequently surrounded by an inflamed periodontium which is consistent with the common clinical belief and observation that rough unpolished restorations or tooth surfaces tend to be prone to plaque formation and retention, and gingival inflammation.

Dental caries is the progressive irreversible demineralization of tooth structure by bacterial acid. Substantial evidence indicates that streptococci are essential for the development of caries. Experiments using gnotobiotics have shown that the most potent causes of dental caries are a limited number of strains of the *S. mutans* group which are able to form cariogenic plaque. The essential properties of cariogenic bacteria include the ability to produce acid, the ability to produce a pH low enough to decalcify tooth substance, the ability to survive and continue to
produce acid at low levels of pH, attachment mechanisms for firm adhesion to smooth tooth surfaces and most importantly the ability to produce adhesive, insoluble plaque polysaccharides.

According to Guang-yun Lai and Ming-yu Li, "Secondary caries, like other dental caries, is initially caused by the activities of microorganisms in dental plaque, so it is possible for any site on the restored teeth which is prone to the bacterial stagnation to develop secondary caries". The article further goes on to state that "secondary caries was detected predominately on the gingival margins of Class II and restorations, while seldom on the Class I restorations and the occlusal part of Class II restorations". This indicates that there may be other plaque retentive factors, such as the class of the cavity that may be worth considering when it comes to restorations of any kind. Therefore the location of the cavity will be considered and recorded when conducting this research.

According to a study done on resin composite, amalgam and glass GIC the percentage of GIC restorations replaced due to secondary caries exceeded the numbers of amalgam and resin composite restorations replaced. The mean age of replaced GIC restorations was also found to be 5 years whereas the age of resin composite and amalgam restorations was found to be 8 years and 10 years respectively. However, this result may be misleading. A possible explanation for these recorded results is the abrasion resistance of GIC. Its poor abrasion resistance results in its use being restricted to non-stress bearing areas such as Class V restorations. The proximity of the restorative material to the gingival crevice make it more difficult to clean and more retentive of plaque. This property also means that the restoration may wear away faster than resin composite and amalgam thus exposing the margins of the cavity to bacterial colonization, plaque accumulation and eventual demineralization.

Gingivitis and periodontitis are diseases of multifactorial aetiology. Gingivitis is an inflammatory response of the gingiva to plaque bacteria. Factors contributing to or exacerbating gingivitis include poor tooth cleaning, dental irregularities providing stagnation areas and restorations or appliances causing stagnation areas. The above mentioned factors all lead to an increased accumulation of plaque thus indicating that plaque is a critical aetiological in the initiation and progression of gingivitis. Several other environmental, acquired and behavioral factors are risk factors for these diseases. These include specific microbiota (eg. Actinobacillus
actinomycetencomitans, Porphyromonas gingivalis, Bacteroides forsythus), cigarette smoking, diabetes mellitus and obesity. In a study conducted in 2004 investigating the clinical and microbiological effects of different restorative materials (amalgam, GIC and resin composite) on the periodontal tissues adjacent to subgingival Class V restorations, it was found that no significant changes in the composition of the subgingival microflora occurred with the amalgam and GIC restorations. However, with composite resin there was a significant increase in the total bacterial counts, and a significant decrease in Gram-positive, aerobic bacteria, which was associated with a significant increase in the gram-negative, anaerobic bacteria. The study concluded that resin composite restorations may have some negative effects on the quantity and quality of subgingival plaque.
CHAPTER 2: RESEARCH PROBLEM, JUSTIFICATION, OBJECTIVES AND HYPOTHESIS

2.1 STATEMENT OF THE PROBLEM
Gingivitis is a disease that affects a significantly large number of people worldwide. According to the NHANES III conducted in the United States between 1988 and 1994, 52.9% of the US population aged 20 and above had gingival bleeding in at least one gingival site. It is also a well known fact that most clinically encountered cases of gingivitis are plaque induced. Dental restorations or appliances can create areas of stagnation where plaque accumulates.

2.2 JUSTIFICATION
The study will generate information regarding gingivitis, plaque retention and their correlation with the type of restorative material used. This hopefully will help dentists worldwide make more informed decisions when choosing a restorative material for use and if indicated, alter a patient’s oral hygiene instructions thus in the long run improving the oral health of individuals worldwide.

2.3 OBJECTIVES
Broad objective;

• To study the plaque retentive ability of different tooth restorative materials and enamel.

Specific objectives;

• To measure the amount of plaque on teeth restored by different materials (Amalgam, GIC, Resin composite and other materials) and, normal healthy teeth in the oral environment
• To measure gingival inflammation on teeth restored by different materials (Amalgam, GIC, Resin composite and other materials) and normal healthy teeth in the oral environment
• To determine the relationship between different restorative materials and plaque levels.
• To determine the relationship between different restorative materials and gingival inflammation.
2.4 HYPOTHESIS
There is no relationship between restorative materials and plaque retention.
CHAPTER 3: MATERIALS AND METHODS

3.1 STUDY AREA
The research will be conducted at the UoN Dental Hospital. The UoN Dental Hospital is a teaching hospital located in along Valley Road, Nairobi, the capital city of Kenya.

3.2 STUDY POPULATION
Adult patients between the ages of 18 and 65 seeking treatment at the UoN Dental Hospital.

3.3 STUDY DESIGN
The study is a cross sectional study.

3.4 STUDY PERIOD
The study shall be conducted from June to October 2014.

3.5 SAMPLING

3.5.1 Sampling method
Patients who will participate in the study shall be selected by convenience sampling whereby data shall be collected from consenting patients irrespective of what restorative material may have been used in any restorations present.

3.5.2 Sample size determination
The sample size to be used shall be calculated using the following formula;

\[ N = \frac{Z^2P(1-P)}{C} \]

Where:

N = Sample size

Z = Z value according to the chosen confidence interval

C = 1-Confidence level
Taking a confidence level of 95%, a Z value of 1.96 and a prevalence of 52.9% (NHANES III 1988-1994),

\[
N = \frac{1.96^2 \times 0.529 \times (1 - 0.529)}{(1 - 0.95)^2}
\]

\[N = 382.868\]

\[N = 382 \text{ persons (for a population greater than 10,000)}\]

However since the population is less than 10,000 the following formula is used;

\[nf = \frac{n}{1 + \frac{N}{n}}\]

Where:

\[nf = \text{the derived sample size for a population less than 10,000}\]

\[n = \text{the derived sample size for a population greater than 10,000}\]

\[N = \text{the estimated number of patients with restorations that visit the University of Nairobi Dental Hospital, Periodontology Clinic within 3 months}\]

\[nf = \frac{382}{1 + \frac{382}{100}}\]

\[nf = 79\]
3.6 INCLUSION AND EXCLUSION CRITERIA

3.6.1 Inclusion criteria
Patients that consent to the study and fall within the ages of 18 and 65.

3.6.2 Exclusion criteria
Patients who do not consent to the study or fall within the ages of 18 and 65.

3.7 DATA COLLECTION INSTRUMENTS AND TECHNIQUES

3.7.1 Instruments
A standard periodontal probe shall be used to probe to check for gingival bleeding on selected teeth. Red disclosing tablets shall be used to disclose any plaque present on selected teeth. The data collected shall be recorded in the Data Collection Form (APPENDIX 2)

3.7.2 Indices
The following indices shall be used to calculate gingival index and plaque score (APPENDIX 1);

i. Loe and Silness gingival index of 1963.

ii. Tureskey’s 1970 modification of Quigley and Hein’s plaque score index.

3.8 ETHICAL CONSIDERATIONS

- Authority to conduct the study shall be sought from the Kenyatta National Hospital Ethics, Research and Standards Board
- Informed consent shall be obtained from every patient participating in the study.
- All data shall be collected in a discrete and anonymous manner and shall be treated with absolute confidentiality.
3.9 LOGISTICS
The study shall be conducted within the University of Nairobi Dental Hospital hence there shall be some degree of convenience. The data shall be collected by a single researcher and the researcher shall be self sponsored financially.

3.10 PERCEIVED BENEFITS
The information from this study could be used to improve the oral health of patients with restorations, reduce the prevalence of secondary caries and prevalence of gingivitis in patients with restorations.

3.11 SCHEDULE OF ACTIVITIES

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<td>Selection of the research topic.</td>
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<tr>
<td>June-July 2014</td>
<td>Development of research proposal</td>
</tr>
<tr>
<td>July 2014</td>
<td>Submission of research proposal to ethics committee</td>
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<tr>
<td>August-September 2014</td>
<td>Data collection</td>
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3.12 BUDGET

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<tr>
<td>Miscellaneous</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>3500</strong></td>
</tr>
</tbody>
</table>
REFERENCES


APPENDIX 1

Indices

i. Loe and Silness gingival index of 1963 which states:

0 = No inflammation
1 = Mild inflammation, slight change in colour, slight edema, no bleeding on probing
2 = Moderate inflammation, moderate glazing, redness, bleeding on probing
3 = Severe inflammation, marked redness and hypertrophy, ulceration, tendency to spontaneous bleeding

iii. Tureskey’s 1970 modification of Quigley and Hein’s plaque score index which states:

0 = No plaque
1 = Separate flecks of plaque at the cervical margin of the tooth
2 = A thin continuous band of plaque (up to 1 mm) at the cervical margin of the tooth
3 = A band of plaque wider than 1 mm but covering less than one-third of the crown of the tooth
4 = Plaque covering at least one-third but less than two-thirds of the crown of the tooth
5 = Plaque covering two-thirds or more of the crown of the tooth
APPENDIX 2

DATA COLLECTION FORM

Patient Serial No: ..........................  Age: ..........................  Gender: Male □  Female □

Oral Hygiene Practices:

Brushes: Once daily □  Twice daily □  Thrice daily □  Other(indicate): ..................................................

Interdental cleaning: Yes □  No □  If “Yes” indicate method: .................................................................

Smoking: Yes □  No □

Relevant Medical Conditions:

DMFT Chart (Indicate extent of tooth occupied by restoration; M-mesial D-distal O-occlusal C-cervical):

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<th>18</th>
<th>17</th>
<th>16</th>
<th>15</th>
<th>14</th>
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<th>24</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
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</thead>
</table>
| Filling Material (Only fill in for filled teeth):
|   | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| Quality of restoration (Comment on; Surface-Smooth/Rough, Margins-Open/Closed and Overhangs):
|   | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| Gingival Index (Only fill in for filled teeth):
|   | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| Plaque Score (Only fill in for filled teeth):
|   | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|   | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
APPENDIX 3

PURPOSE OF THE STUDY

I, MUTAKHA JESSE SEMBENE OMUTAKHA am a third year dental student from the University of Nairobi and would like to seek your consent to participate in a study aimed at determining the relationship between different restorative materials and plaque retention. The information I get is part of my research for a project as a partial fulfillment for the degree of Bachelor of Dental Surgery (BDS).

EXPECTED BENEFITS

- The report will contribute to the fulfillment of the requirements of the Bachelor of Dental Surgery program in the University of Nairobi.
- The study may be used to help improve the oral health of patients with restorations (fillings).
- The study may be used to help reduce the prevalence of gingivitis (gum disease) in patients with restorations.
- The study may be used to help reduce the failure rate of restorations (fillings) in the oral cavity.

ANTICIPATED RISKS

No risk is anticipated for participating in the study.

CONFIDENTIALITY

The information given to the researcher will be kept in strict confidence. No confidential information will be revealed, released or published.

If you are satisfied with my explanation and are willing to participate, please sign the consent form.

You are also free to refrain from participating in the study or withdrawing at any point in time without fear of victimization.

Researcher

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Fax: 725272
Telegrams: MEDSUP, Nairobi
CONSENT FORM

I .......................................................... having understood the nature of the study as explained by JESSE SEMBENE OMUTAKHA MUTAKHA of the University Of Nairobi am willing to participate in the study.

Name: ..........................................................
Signed: ..........................................................
Date: ....../....../20......

I confirm that I have explained the nature of the study to the patient.

Name: ..........................................................
Signed: ..........................................................
Date: ....../....../20......