DOCTORATE THESIS `SUMMARY

Experimental and clinico-statistical studies regarding management of noncariogenic cervical lesions

Scientific coordinator
Prof. dr. ANDRIAN SORIN

PhD Student
RADU TITUS-MARIUS

2011
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INTRODUCTION

Noncariogenic dental lesions appear as a results of combinations between abrasion, attrition and erosion processes. During lifetime a patient can present these processes in different proportion with different intensity degrees, resulting a variable clinical aspect of these noncariogenic lesions and difficulties related to their diagnosis.

Though noncariogenic dental lesions did not presented interest for practiciens and researchers, this situation changed in last 10 years, because of the constant increasing of their prevalence for patients of all age categories. That is why number of studies regarding noncariogenic cervical lesions increased from a few studies yearly in 1980-1990 to over 50/year in periode 2000-2010.

The ethiopatogeny of noncariogenic cervical lesions is complex implying many factors, some of them acting isolated, but in most cases there is a multifactor etiology with internal and external factors. Related to the fact that dental erosion is a process with progressive rate increasing, the preventive and therapeutical management becomes extremely important for a long term health of dental tissues. Special attention must be focused on the children of age 5-14 because of surprisingly frequent apparition of dental erosion at this age group. In this stage the damage of definitive dentition caused by erosive attacks can compromise interocclusal and intermaxilar relations in the adult life.

Practiciens must posess theoretical and practical knowledges regarding the interaction between chemical, biological and behavioral factors with major role in dental erosions formation, factors that explain differences between patients related to the noncariogenic cervical pathology.

The early diagnosis of dental erosions to childrens and young adults will allows the approach of efficient preventive-therapeutical measures applyied simultaneously with the management of risk factors.

Actually there is a confusion regarding signs and symptoms of noncariogenic dental lesions as well as adequate measures of management within uninformed people and that is why, in the absence of cervical hipersensibility, patients do not require dental treatments for this type of dental patolgy.

Dental erosions must be considered a challenge for the dentists in XXI century because of the actual long term preserving of teeth as well as the continuous changing of life style.
VI. THE STUDY REASONS. THE STUDY AIMS. GENERAL OBJECTIVES. DATA SELECTION AND PROCESSING.

The theme selected for this research is actual related to the fact that the deep knowledges of epidemiology, etiopathogenic mechanisms and the efficiency of different therapeutical methods and materials used in preventive and therapeutical management of noncariogenic cervical lesions, are extremely useful in actual context characterised by an alarming increasing of the erosions, abrasions and combined noncariogenic cervical lesions incidence. All these reasons justify the choice of the research theme.

VI.2. THE STUDY AIMS.

Present study has the following aims:
- to determine the interrelations between different elements/conditions and the noncariogenic lesions located to enamel-cement joint, using a statistical study based on specific epidemiological tests;
- to increase the base of knowledges related to intertisular raports to the level of enamel-cement, identifying and comparatively analysing using SEM microscopy, different categories of ECJ, related to dental groups and dental surfaces;
- to assess the erosive capacity on different types of composite resins of different antiseptic oral mouthwashes and acid beverages;
- to assess the effects at ultramicroscopic levels of acid beverages on dental hard tissues (enamel, dentine);
- to determine the clinical performance (longevity) of cervical direct restorations from microhybride composite resins, conventional glassionomer cements, RMGC (resin-modified glassionomer cements) and compomers;
- to assess the enamel behavior to the level of enamel-dentine jonction for different categories of loading related to healthy teeth, teeth affected by dental caries and teeth with direct restorations (amalgam, composite resins, glassionomer cements).

V.3. GENERAL OBJECTIVES

The researches were focused on a few directions as follows:
- clinical study on a group of direct cervical restorations realised by composite resins, glassionomer cements and compomers, related to paramaters of clinical performance using Ryge indices modified USPHS;
- statistical clinical-epidemiological study related to the dental erosions prevalence and their etiopatogenical relations with favourising factors;
- SEM microscopy focused on the determination of intertisular raports at the level of enamel-cement jonction;
- paraclinical study (chemical analysis, profilometry) focused on the ultrastructural changing to the level of enamel and dentine under the acid actions of beverages;
- study of finite element analysis (FEA) focused on the assessment of cervical area resistance to tensions induced by paraaxial forces.
VII.1. Introduction

The activity of Oral Health Center (submitted to OMS standards) has a series of objectives focused on efficient and well coordinated prevention related to the real needs of population as well as on treatments based on modern methods and techniques. Related to systemic integrative character of stomatognatic system, the statistical research proposed to collect data related to all elements that can influence the homeostatic balance and can give references on the existent diseases evolution. Starting from general epidemiological studies with high practical applications, processed by OHC, this study tried to use their investigation methods for the specific interest area of noncervical dental lesions (dental erosions).

VII.2. STUDY AIMS

The objectives of this specific research are as follows:

- to establish the prevalence of different noncariogenic cervical lesions with special focus on dental erosions;
- to establish correlations between dental erosions and different categories of etiopatological factors;
- to establish correlations between dental erosions and favourising factors;
- to establish the needs of treatment.

VII.3. MATERIAL AND METHODS

First, data collecting was based on an investigation paper with following sections:

- economical and social status;
- environment factors;
- oral hygiene behaviour;
- general status;
- dental prevention

The data related to dental erosions were selected – prevalence (total patients, total teeth) and associations between etiopathological factors and frequency rate.

The specific study was processed on the following stages:
1. study group presentation– age, sex repartition
2. dental erosions prevalence in the selected lot
3. determination of correlation between dental erosions and diverse etiological factors;
4. dental erosion prevalence related to dental group, dental surfaces.
The study group included 16383 patients with different social categories and age categories. Patients with dental erosions were 763 (LE)

Fig. 1. Distribution related to ages in study group

Fig. 2. Distribution related to sex in study group

Fig. 3. Distribution related to sex/environment

Table 1. Distribution related to age intervals
Fig. 4. Distribution related to age intervals for patients with dental erosions

Table 2. Distribution related to age, sex and dental erosions prevalence
Dental erosions were present to 641 patients with age over 18. Prevalence of dental erosions related to sex are as follows: males 2.81%, females 3.57%. Prevalence of dental erosions in study group with age over 18 is 6.38%.

For females prevalence of dental erosions progress from 7.8% for age 18 – 25 to 17.55% for age 26 – 35, and reach maximum value of 25.91% for age 46 – 55 de ani. For males prevalence of dental erosions progress from 10.64% for age 18 – 25 de ani to 23.05% for age 46 – 55.
a. External factors

a.1. Working environment

The prevalence of dental erosions was measured for control group and study group. The control group was defined as patients working in non-toxic environment (719 patients). The study group was defined as patients working in toxic environment (945 patients) and environment with powders (611 patients).

![Image]

**Fig. 8. Prevalence of dental erosions related to working environment**

The prevalence of dental erosions is higher for patients working in environment with powders (9,66%) comparing with patients working in toxic environment (6,77%), and lower for patients working in non-toxic environment (5,90%).

a.2. Nutrition

- **Fresh fruits consume (weekly)**

10320 stated a consume of fresh fruits weekly. 487 patients (4,68%) considered as non-consumers of fresh fruits, 1632 patients (15,67%) consume fresh fruits once weekly, 2642 (25,36%) consume fresh fruits twice weekly, 2481 patients (23,82%) consume fresh fruits three times weekly; most patients (3078) consume fresh fruits four times weekly (29,55%).
Fig. 9. Prevalence of fresh fruits weekly and correlation with prevalence of dental erosions

- **Consume of drinks**
  
The study focused on drinks as follows: coffee, black tea, green tea.

Table 3. Prevalence and correlation of dental erosions with drink category

- **Consume of juices**
  
The study focused on juices as follows: acidulated juices, natural juices.
Tabel 1. Prevalence of dental erosions related to categories of juices (1=acidulated juices, 2=natural juices, 3=others)

Around 41.5% (4323) patients consume acidulated juices, 17.11% (1782) patients consume natural juices and 24.26% (2527) patients consume other type of juices. The statistical tests couldn’t prove the existence of strong correlation between consume of juices and dental erosions.

Smoking

The prevalence of dental erosions seems to be higher for patients smoking at least four times daily (8.6%), comparing with only 6.28% for the other categories of smokers.

Tabel 5. Correlation between smoking and prevalence of dental erosions
- **Consume of alcohol**

  The study focused on alcoholic drinks as follows: beer, wine, distilled drinks.

  ![Summary Frequency Table](image)

  Table 6. Prevalence and correlation of dental erosions with consume of alcoholic drinks (1 = non-consumers, 2 = beer, 3 = wine, 4 = distilled drinks)

  The highest prevalence of dental erosions is associated with wine consumers (7.29%), while non-consumers of alcoholic drinks present lowest value of dental erosions (6.08%). However the statistical tests did not found a strong statistical correlation between consume of alcoholic drinks and prevalence of dental erosions.

  a.3. **Medicine related to systemic diseases**

  Our study focused on diseased patients treated with medicines associated with reduced salivary flow.

  ![Summary Frequency Table](image)

  Table 7. Prevalence and correlation of dental erosions with hypertension

  Patients with hypertension present an increase of dental erosions prevalence (9.57%), comparing with mean value of study group (6.28%).
Table 8. Prevalence and correlation of dental erosions with myocardium disorders

Patients with myocardium disorders present a statistical significant increase of dental erosions (10.27%) comparing with mean value of study group (6.28%).

Table 9. Prevalence and correlation of dental erosions with angina

Patients with angina are not related with a statistical increase of prevalence of dental erosions.

Table 10. Prevalence and correlation of dental erosions with diabetis

Patients with diabetis present a higher prevalence (significant statistical) of dental erosions (8.91%) comparing with mean value of 6.28%
The patients with Parkinson disease present an increase of dental erosions prevalence (13.78%), representing the most affected category of patients taken in study.

VII.4. Conclusions

- Our study highlights the high level of dental erosions prevalence in investigated population group, the high number of patients taken in study allowing to conclude that dental erosions represent a well-defined pathology of oral cavity.
- The dental erosions are initiated by numerous ethiological factors like oral hygiene, nutrition, categories of consumed drinks, systemic diseases and related medication, smoking and compliance with dentists services.
CHAPTER VIII

STUDY REGARDING EROSI VE EFFECT OF BEVERAGES AND ORAL ANTISEPTIC SOLUTIONS ON HARD DENTAL TISSUES

VIII.1. Introduction
The chronic consume of acid foods contributes to the apparition of dental erosion, attrition, abrasion or dental caries. Their effects on hard dental tissues depend on their pH and acidity (erosive capacity). Their effects at microscopic level can be analyses using hardness measurement, surface profilometry, chemical analysis of dissolved minerals, microradiography, SEM microscopy, force atomic microscopy, ultrasonic measurements.

VIII.2. Study aims
1. assessment of pH and acidity for 3 acid beverages and 2 oral mouthwashes;
2. measurement of calcium and phosphor in enamel and dentine before and after prolonged action of 3 acid beverages and 2 oral mouthwashes;
3. analysis of erosive effect (3 acid beverages, 2 oral mouthwashes) using SEM microscopy.

VIII.3. Material and methods

1. Determination of pH and acidity
   Determination of pH and acidity were performed using electronic pH-metre HANNA pH 210. All measurement were performed on 60 ml solution at the room temperature, using calibration after each measurement. Each measurement was repeated 10 times, final result representing the average value.

2. Determination of calcium and phosphor concentration before/after prolonged imersion of enamel and dentine samples
   The tests were performed on 18 extracted molars without cariogenic or noncariogenic lesions. The teeth were cut mesio-distal with diamond discs. The samples were divided in 6 groups- one control groups and five study groups (samples imersed in Nestea lemon, Coca Cola and wine; 2 oral mouthwashes: Listerine, Corsodyl). The samples were imersed for 14 days in Corsodyl Listerine and 30 days in Nestea lemon, wine (Merlot, Recas) and Coca Cola. The concentration of calcium and phosphor ions was determined before and after imersion, using EDX QUANTAX QX2, produced by BRUKER/ROENTEC Germania.

3. Analysis of erosive effect of acid beverages and oral mouthwashes using SEM microscopy.
   The morphology of dental sections was analysed using SEM microscopy (SEM model VEGA II LSH, produced by TESCAN Cehia). The morphological aspects of enamel and dentine surfaces were analysed before and after imersion in erosive solutions (samples imersed in Nestea lemon, Coca Cola and wine; 2 oral mouthwashes: Listerine, Corsodyl).
VIII.4. Results and discussions

1. Determination of pH and acidity

In figure 10 are presented the values of pH for the studied erosive substances compared with critical pH (5,5). The highest pH is associated with Corsodyl (5,6), the lowest pH is associated with Coca-Cola (2,85).

Fig.10. pH values of erosive solutions

In table 12 are presented values for the acidity of erosive solutions. The highest value is associated with Coca-Cola, followed by wine, Nestea lemon, Listerine and Corsodyl.

<table>
<thead>
<tr>
<th></th>
<th>Coca Cola</th>
<th>Nestea lemon</th>
<th>wine</th>
<th>Listerine</th>
<th>Corsodyl</th>
</tr>
</thead>
<tbody>
<tr>
<td>acidity (mg/ml)</td>
<td>0,58</td>
<td>0,33</td>
<td>0,30</td>
<td>0,11</td>
<td>0,04</td>
</tr>
</tbody>
</table>

Table12 Value of erosive solutions acidity

2. Determination of calcium and phosphor concentration in enamel and dentine

In control group, enamel chemical composition is presented in fig.11. The average values in enamels samples are as follows: calcium ions 46,81 mg%, phosphor ions 19,26 mg%.

Fig.11. Chemical composition of intact enamel (control group)
In control group, dentine chemical composition is presented in fig.12. The average values in enamels samples are as follows: calcium ions 31.3 mg%, phosphor ions 14.87 mg%.

![Fig.12. Chemical composition of intact dentine (control group)](image)

In group of enamel samples imersed in Listerine, enamel chemical composition is presented in fig.13. The average values in enamels samples are as follows: calcium ions 53.35 mg%, phosphor ions 21.25 mg%.

![Fig.13. Chemical composition of enamel samples imersed in Listerine](image)

In group of dentine samples imersed in Listerine, dentine chemical composition is presented in fig.14. The average values in enamels samples are as follows: calcium ions 8.19 mg%, phosphor ions 3.35 mg%.
In group of enamel samples imersed in Nestea lemon, enamel chemical composition is presented in fig.15. The average values in enamels samples are as follows: calcium ions 22.56 mg%, phosphor ions 9.57 mg%.

In group of dentine samples imersed in Nestea lemon, dentine chemical composition is presented in fig.16. The average values in enamels samples are as follows: calcium ions 21.8 mg%, phosphor ions 9.57 mg%.
In group of enamel samples imersed in Listerine, enamel chemical composition is presented in fig.26. The average values in enamels samples are as follows: calcium ions 29,74 mg%, phosphor ions 15,21 mg%.

In group of dentine samples imersed in wine, dentine chemical composition is presented in fig.27. The average values in enamels samples are as follows: calcium ions 1,56 mg%, phosphor ions 0,28 mg%.
In group of enamel samples imersed in Listerine, enamel chemical composition is presented in fig.28. The average values in enamels samples are as follows: calcium ions 46,67 mg%, phosphor ions 27,57 mg%.

![Fig.19. Chemical composition of enamel samples imersed in Corsodyl](image)

In group of dentine samples imersed in Listerine, dentine chemical composition is presented in fig.29. The average values in enamels samples are as follows: calcium ions 30,46 mg%, phosphor ions 13,8 mg%.

![Fig.20. Chemical composition of dentine samples imersed in Corsodyl](image)

In table 13 are presented the average values of calcium and phosphor concentrations in group samples and samples after imersion in erosive solutions.

<table>
<thead>
<tr>
<th></th>
<th>Ca</th>
<th>PO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>enamel</td>
<td>dentine</td>
</tr>
<tr>
<td>distilled water</td>
<td>46,7</td>
<td>34,5</td>
</tr>
<tr>
<td>nestea</td>
<td>36,9</td>
<td>1,8</td>
</tr>
<tr>
<td>coca cola</td>
<td>22</td>
<td>1,5</td>
</tr>
<tr>
<td>corsodyl</td>
<td>44,6</td>
<td>28,3</td>
</tr>
<tr>
<td>listerine</td>
<td>45</td>
<td>8,1</td>
</tr>
<tr>
<td>wine</td>
<td>29,7</td>
<td>1,4</td>
</tr>
</tbody>
</table>

Table 13. Average values of calcium and phosphor concentrations in enamel and dentine
There is a tendency to decrease the calcium concentrations in enamel and dentine after immersion of samples in erosive solutions. The lowest concentrations of calcium were obtained for Coca-Cola, followed (increasing range) by Nestea, wine, Listerine and Corsodyl.

3. The assessment of erosive effect using SEM microscopy

In figures 21-22 are presented the aspects of enamel and dentine before immersion in erosive solutions. The smear-layer on enamel surface is observed in fig.30, the regular aspect of dentine is observed in fig.31.

![Fig.21. Enamel aspect in control sample](image1)

![Fig.22. Dentine aspect in control sample](image2)

In figures 23-24 are presented the aspects of enamel and dentine after immersion in Listerine. We see areas of enamel demineralisation and opening of dentinal tubules.

![Fig.23. Enamel aspect in enamel sample after immersion in Listerine](image3)

![Fig.24. Dentine aspect in dentine sample after immersion in Listerine](image4)
In figures 25-26 are presented the aspects of enamel and dentine after immersion in Listerine. We see areas of enamel demineralisation and opening of dentinal tubules as well as spheric structures on the surface of enamel and dentine (fig.27-28).

In figures 27-28 are presented the aspects of enamel and dentine after immersion in wine. We see areas of enamel demineralisation and opening of dentinal tubules as well as poliedric, unregulated structures on the surface of enamel and dentine (fig.29-30).
In figures 31-32 are presented the aspects of enamel and dentine after imersion in Listerine. We see areas of enamel demineralisation and opening of dentinal tubules.

In figures 33-34 are presented the aspects of enamel and dentine after imersion in Listerine. We see clean areas of enamel without smear-layer and opening of dentinal tubules.
Numerous clinical studies have demonstrated the erosive ability of food and beverages. Especially beverages like Coca-Cola required high quantity of basic solutions to reach neutral pH. pH and buffer properties can’t explain completely the erosive potential. There are relevant factors like mineral content, acid concentration (phosphoric, citric) and fluor ions presence. Our study showed that Coca-Cola has lowest values for pH and buffer capacity, close to data presented by similar studies. SEM images confirm the results of similar SEM studies related to ultrastructural aspects of enamel and dentine surfaces following action of acid solutions. Our study correlate the opening of dentinal tubules with the apparition of cervical hypersensibility following both to the dinamic changes of dentinal fluid and loss of dental tissues.

IX.5. CONCLUSIONS

- Coca Cola has lowest pH values and acidity, followed (increasing range) by wine, Nestea lemon, Listerine şi Corsodyl;
- All 3 acid beverages and 2 oral mouthwashes determined significant decreases of calcium, phosphor concentrations both for enamel and dentine;
- The action of oral mouthwashes Listerine şi Corsodyl over enamel surfaces did not affected calcium concentration at the level of enamel surfaces, while the acid beverages (Coca-Cola, Nestea lemon, wine) determined significant decreases of calcium concentrations.
CHAPTER IX

STUDY REGARDING BEHAVIOUR OF COMPOSITE RESINS TO ACIDE ATTACK

IX.1. Introduction

One of the most important feature linked to longevity of restoration materials in oral cavity is the resistance to desintegration after acid attacks. The behaviour of direct restorations depends on physical and mecanical properties as well as the degree of biodegradation in an oral environment with different values of humidity and pH.

IX.2. Study aims

The objective of this research is to assess the erosive effect of antiseptic mouthwashes and acid beverages on the different types of composite resins.

IX.3. Materials and methods

In study were included 30 extracted molars with intact occlusal surface. Class I cavities and direct restorations from two different composite resins were performed: microhibride composite resin (Filtek Z250, 3M ESPE) and hibride composite resin (Charisma, Heraeus Kulzer). Samples were cut with diamond discs in buccal-oral direction and divided in five groups: control group, immersion in tea (Nestea lemon), immersion in Coca Cola, immersion in Corsodyl, immersion in Listerine. The immersion lasted 14 days for Corsodyl and Listerine and 30 days for Nestea lemon and Coca cola. The sections were analysed using force atomic microscopy and values for surface roughness were calculated.

IX.4. Results

In table 14 are presented the values of roughness (μm) for hibride composite resin Charisma after immersion in distilled water, Coca Cola, Listerine, Corsodyl and Nestea.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Distilled Water</th>
<th>Coca Cola</th>
<th>Nestea</th>
<th>Listerine</th>
<th>Corsodyl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>1,17</td>
<td>3,50</td>
<td>3,43</td>
<td>3,38</td>
<td>3,29</td>
</tr>
<tr>
<td>Sample 2</td>
<td>1,16</td>
<td>3,53</td>
<td>3,39</td>
<td>3,36</td>
<td>3,34</td>
</tr>
<tr>
<td>Sample 3</td>
<td>1,18</td>
<td>3,52</td>
<td>3,39</td>
<td>3,39</td>
<td>3,35</td>
</tr>
<tr>
<td>Sample 4</td>
<td>1,17</td>
<td>3,51</td>
<td>3,38</td>
<td>3,37</td>
<td>3,32</td>
</tr>
<tr>
<td>Sample 5</td>
<td>1,16</td>
<td>3,49</td>
<td>3,39</td>
<td>3,42</td>
<td>3,31</td>
</tr>
<tr>
<td>Sample 6</td>
<td>1,18</td>
<td>3,52</td>
<td>3,34</td>
<td>3,38</td>
<td>3,32</td>
</tr>
</tbody>
</table>

Table 14. The roughness values for hibride composite resins
There is a significant tendency of surface roughness increase after immersion in acid solutions. From an average value of 1.17 (immersion in distilled water), surface roughness values increase to 3.32 (immersion in Corsodyl), 3.38 (immersion in Listerine), 3.39 (immersion in Nestea) and 3.51 (immersion in Coca Cola) (fig.35).

Fig.35. The average values of surface roughness for hibride composite resins

In table 15 are presented the values of roughness (μm) for microhibride composite resine Z250 after immersion in distilled water, Coca Cola, Listerine, Corsodyl and Nestea.

<table>
<thead>
<tr>
<th>Proba</th>
<th>Apă distilată</th>
<th>Coca Cola</th>
<th>Nestea</th>
<th>Listerine</th>
<th>Corsodyl</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1</td>
<td>4</td>
<td>3.30</td>
<td>3.28</td>
<td>3.14</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>5</td>
<td>3.31</td>
<td>3.29</td>
<td>3.14</td>
</tr>
<tr>
<td>3</td>
<td>1.1</td>
<td>6</td>
<td>3.27</td>
<td>3.27</td>
<td>3.11</td>
</tr>
<tr>
<td>4</td>
<td>1.1</td>
<td>4</td>
<td>3.29</td>
<td>3.30</td>
<td>3.16</td>
</tr>
<tr>
<td>5</td>
<td>1.1</td>
<td>5</td>
<td>3.30</td>
<td>3.28</td>
<td>3.14</td>
</tr>
<tr>
<td>6</td>
<td>1.1</td>
<td>6</td>
<td>3.29</td>
<td>3.28</td>
<td>3.16</td>
</tr>
</tbody>
</table>

Table 15. The roughness values for microhibride composite resins

There is a significant tendency of surface roughness increase after immersion in acid solutions. From an average value of 1.11 (immersion in distilled water), surface roughness values increase to 3.14 (immersion in Corsodyl), 3.28 (immersion in Listerine), 3.29 (immersion in Nestea) and 3.45 (immersion in Coca Cola) (fig.36).
For each type of erosive solution, the recorded average values of surface roughness were different related to type of composite resines (microhibride, hibride). The microhibride composite resins presented higher values of surface roughness comparing with hibride composite resins.

In figures 37-46 are presented aspects recorded with atomic force microscopy for samples of microhibride composite resins and hibride composite resins.

Fig. 37. Aspect of composite resin Z250 after imersion in distilled water

In fig.37 is presented the surface aspect for sample of Charisma. The values of surface roughness are higher comparing with the surface aspect of Z250 (fig.39).
Fig. 38. Aspect of composite resin Charisma after imersion in distilled water

In figure 39 is presented the surface aspect of sample Z250 after imersion in Coca Cola.

Fig. 39. Aspect of composite resin Z250 after imersion in Coca Cola

In figure 40 is presented the surface aspect of sample Charisma after imersion in Coca Cola.

Fig. 40. Aspect of composite resin Charisma after imersion in Coca Cola
In figure 41 is presented the surface aspect of sample Z250 after immersion in Corsodyl.

Fig. 41. Aspect of composite resin Z250 after immersion in Corsodyl

In figure 42 is presented the surface aspect of sample Charisma after immersion in Corsodyl.

Fig. 42. Aspect of composite resin Charisma after immersion in Corsodyl

In figure 43 is presented the surface aspect of sample Z250 after immersion in Listerine.

Fig. 43. Aspect of composite resin Z250 after immersion in Listerine
In figure 44 is presented the surface aspect of sample Charisma after imersion in Listerine.

Fig. 44. Aspect of composite resin Charisma after immersion in Listerine

In figure 45 is presented the surface aspect of sample Z250 after immersion in Nestea lemon.

Fig. 45. Aspect of composite resin Z250 after immersion in Nestea lemon

In figure 46 is presented the surface aspect of sample Charisma after immersion in Nestea lemon.

Fig. 46. Aspect of composite resin Charisma after immersion in Listerine
The recorded data were processed and statistically analysed to establish the differences regarding surface roughness for both types of composite resins after immersion in acid environments. The conclusion was that these differences are statistically significant.

Table 16 presents the data of descriptive statistics for samples Charisma immersed in distilled water, Coca Cola, Listeryne, Corsodyl, Nestea lemon.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apadistilata</td>
<td>6</td>
<td>1.1700</td>
<td>.00894</td>
<td>1.16</td>
<td>1.18</td>
</tr>
<tr>
<td>Coca</td>
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<td>3.5117</td>
<td>.01472</td>
<td>3.49</td>
<td>3.53</td>
</tr>
<tr>
<td>Lysterine</td>
<td>6</td>
<td>3.3967</td>
<td>.01751</td>
<td>3.38</td>
<td>3.43</td>
</tr>
<tr>
<td>Corsodyl</td>
<td>6</td>
<td>3.3833</td>
<td>.02066</td>
<td>3.36</td>
<td>3.42</td>
</tr>
<tr>
<td>Nestea</td>
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<td>3.3217</td>
<td>.02137</td>
<td>3.29</td>
<td>3.35</td>
</tr>
</tbody>
</table>

Table 16. The data of descriptive statistics for Z250

Table 17 presents the data of descriptive statistics for samples Z250 immersed in distilled water, Coca Cola, Listeryne, Corsodyl, Nestea lemon.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apadistilata</td>
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<td>.01033</td>
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<td>1.13</td>
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<tr>
<td>Coca</td>
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<td>3.4500</td>
<td>.00894</td>
<td>3.44</td>
<td>3.46</td>
</tr>
<tr>
<td>Lysterine</td>
<td>6</td>
<td>3.2933</td>
<td>.01366</td>
<td>3.27</td>
<td>3.31</td>
</tr>
<tr>
<td>Corsodyl</td>
<td>6</td>
<td>3.2833</td>
<td>.01033</td>
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</tr>
<tr>
<td>Nestea</td>
<td>6</td>
<td>3.1417</td>
<td>.01835</td>
<td>3.11</td>
<td>3.16</td>
</tr>
</tbody>
</table>

Table 17. The data of descriptive statistics for Z250

The Wilcoxon test was performed to establish the statistical differences between values of surface roughness for both types of composite resins before and after immersion in acid solutions. Significant results were obtained regarding surface roughness before and after immersion in Coca Cola, Listeryne, Corsodyl, Nestea lemon as well as between two types of composite resins (Charisma, Z250) comparing values recorded after immersion in acid solutions with values recorded after immersion in distilled water (control group).
IX.5. CONCLUSIONS

- In experimental conditions created in this study, surface roughness of composite resins was affected both for hibride and microhibride composite resins after immersion in acid environment;
- The composite resins with higher diameters of fillers were more sensitive to degradation after exposure in acid environments;
- The most aggressive environment was Coca Cola, followed (decreasing range) by Nestea lemon, Listerine and Corsodyl.
CHAPTER X

**CLINICAL STUDY REGARDING LONGEVITY OF CERVICAL DIRECT RESTORATIONS RELATED TO DIVERSE MATERIALS**

X.1. Introduction

The causes of limited longevity of cervical direct restorations are not fully explained. In these conditions the decision to restore cervical noncariogenic lesions must be taken after a careful analysis of clinical features and possibilities to eliminate chemical, biological and behavioural factors. The use of bioadhesive materials in the direct therapy of noncariogenic lesions must be related to the numerous data of studies focused on their clinical performance.

X.2. Study aims

The objective of this research was to determine clinical performance of direct restorations from microhbride composite resin, conventional glassionomer cement, RMGC and compomer.

X.3. Materials and methods

The study started with criteria Ryge recording for 80 direct restorations of noncariogenic dental lesions (erosions, abrasions, combined lesions) at the level of both anterior and posterior teeth performed by a single dentist. The materials were as follows: microhbride composite resin Amaris (VOCO), compomer Dyract (DeTreyDentsply), RMGC Fuji IILC (GC), conventional glassionomer cement Ketac Molar (ESPE). The study included 35 patients (21 females, 16 males) with age 21-58. At the study finalisation were analysed a number of 18 direct restorations with Amaris, 17 direct restorations with Dyract, 15 direct restorations with Fuji IILC, 14 direct restorations with Ketac. The criteria Ryge recording was performed at 6 months, 12 months, 24 months (table 1): marginal integrity, marginal coloration, colour, surface status, anatomic contour. The retention rate was recorded for each material. The exclusion criteria were as follows: bruxism, unsatisfactory hygiene (high cariogenic risk), occlusal trauma. The results presentation was performed using graphs in Microsoft Excel.
X.4. Results and discussions

In following images are presented clinical aspects of cervical direct restorations with Amaris (microhibride composite resin) (fig.47), Dyract (compomer) (fig.48), Fuji IILC (RMGC) (fig.49), Ketac Easy Mix (conventional glassionomer cement) (fig.50).

Fig.47. Direct cervical restoration with microhibride composite resin Amaris (3.3.)

![Fig.47](image)

Fig.48. Direct cervical restoration with compomer Dyract (4.3.)

![Fig.48](image)
Fig 49. Direct cervical restoration with RMGC Fuji IILC (2.3.)

Fig 50. Direct cervical restoration with glassionomer cement Ketac Molar (3.6.)

In graphs 91-96 are presented the results of this research regarding indices Ryge modified USPHS of 18-24 months direct cervical restorations.
Retention rate values were as follows: 6 months- Amaris 100%, Dyract 100%, Fuji IILC 100%, Ketac Molar 92.8%; 12 months- Amaris 94.4%, Dyract 94.1%, Fuji IILC 93.3%, Ketac Molar 85.7%, 24 months- Amaris 88.8%, Dyract 88.2%, Fuji IILC 86.6%, Ketac Molar 71.4% (fig. 60.a-60.c).

Fig. 60.a. Retention rate - 6 months

Fig. 60.b. Retention rate- 12 months

Fig. 60.c. Retention rate- 24 months
The values for marginal integrity were as follows: 6 months- Amaris A-84%, B-16%, C-9%; Dyract A-71%, B-29%, C-0%; Fuji IILC A-94%, B-6%, C-0%; Ketac Molar A-93%, B-7%, C-0%; 12 months- Amaris A-45%, B-49%, C-6%; Dyract A-36%, B-52%, C-12%; Fuji IILC A-60%, B-40%, C-0%; Ketac Molar A-58%, B-42%, C-0%; 24 months- Amaris A-33%, B-55%, C-12%; Dyract A-12%, B-64%, C-24% Fuji IILC A-53%, B-40%, C-7%; Ketac Molar A-58%, B-36%, C-6% (fig. 61.a-61.i.).

**Fig.61.a.** Marginal integrity (6 months-indices C)

**Fig. 61.b.** Marginal integrity (24 months-indices C)
The values for marginal coloration were as follows: 6 months- Amaris A-100%, B-0%, C-0%; Dyract A-100%, B-0%, C-0%; Fuji IILC A-100%, B-0%, C-0%; Ketac Molar A-100%, B-0%, C-0%; 12 months- Amaris A-78%, B-22%, C-0%; Dyract A-64%, B-36%, C-0%; Fuji IILC A-86%, B-14%, C-0%; Ketac Molar A-87%, B-13%, C-0%; 24 months- Amaris A-61%, B-33%, C-6%; Dyract A-42%, B-46%, C-12%; Fuji IILC A-73%, B-27%, C-0%; Ketac Molar A-79%, B-21%, C-0% (fig. 62.a-62.i).

**Fig. 62.c.** Marginal coloration (6 months-indices C)

**Fig.62.b.** Marginal coloration (12 months-indices C)

**Fig. 62.c.** Marginal coloration (24 months-indices C)
The values for colour were as follows: 6 months- Amaris A-100%, B-0%, C-0%; Dyract A-100%, B-0%, C-0%; Fuji IILC A-40%, B-60%, C-0%; Ketac Molar A-0%, B-0%, C-100%; 12 months- Amaris A-91%, B-9%, C-0%; Dyract A-88%, B-12%, C-0%; Fuji IILC A-20%, B-60%, C-20%; Ketac Molar A-0%, B-0%, C-100%; 24 months- Amaris A-83%, B-17%, C-0%; Dyract A-76%, B-24%, C-0%; Fuji IILC A-20%, B-60%, C-20%; Ketac Molar A-0%, B-0%, C-100% (fig. 63.a-63.i).

**Fig. 63.a.** Colour (6 months-indices C)

![Fig. 63.a. Colour (6 months-indices C)](image)

**Fig. 63.b.** Colour (12 months-indices C)

![Fig. 63.b. Colour (12 months-indices C)](image)

**Fig. 63.c.** Colour (24 months-indices C)

![Fig. 63.c. Colour (24 months-indices C)](image)
The values for surface quality were as follows: 6 months- Amaris A-100%, B-0%, C-0%; Dyract A-100%, B-0%, C-0%; Fuji IILC A-80%, B-20%, C-0%; Ketac Molar A-0%, B-71%, C-29%; 12 months- Amaris A-89%, B-11%, C-0%; Dyract A-88%, B-12%, C-0% Fuji IILC A-60%, B-40%, C-0%; Ketac Molar A-0%, B-59%, C-41%; 24 months- Amaris A-78%, B-22%, C-0%; Dyract A-76%, B-24%, C-0%; Fuji IILC A-20%, B-60%, C-20%; Ketac Molar A-0%, B-0%, C-100% (fig. 64.a-64.i).

**Fig. 64.a.** Surface quality (6 months-indices C)

**Fig. 64.b.** Surface quality (12 months-indices C)

**Fig. 64.c.** Surface quality (24 months-indices C)
The values for anatomic contour were as follows: 6 months- Amaris A-100%, B-0%, C-0%; Dyract A-100%, B-0%, C-0%; Fuji IILC A-93%, B-7%, C-0%; Ketac Molar A-92%, B-8%, C-0%; 12 months- Amaris A-100%, B-0%, C-0%; Dyract A-100%, B-0%, C-0%; Fuji IILC A-86%, B-14%, C-0%; Ketac Molar A-84%, B-16%, C-0%; 24 months- Amaris A-94%, B-6%, C-0%; Dyract A-88%, B-12%, C-0%; Fuji IILC A-80%, B-20%, C-0%; Ketac Molar A-72%, B-28%, C-0% (fig. 65.a-65.i).

**Fig. 65.a. Anatomic contour (6 months-indices C)**

**Fig. 65.b. Anatomic contour (12 months-indices C)**

**Fig. 65.c. Anatomic contour (24 months-indices C)**
In clinical studies the success of coronal restoration material is indicated by clinical performance in oral cavity and its longevity. The ADA standards establish a minimum retention rate of 90% after 18 months, result obtained in our study for RMGC (Fuji IILC), conventional glassionomer cement (Ketac Molar) and microhybride composite resin (Amaris), after assessment at 24 months. The factors that contributed to this successful retention rate were the proper patients selection and proper technic, good isolation, removal of traumatic occlusion and the quality of adhesive system for Amaris (contributing to the buffering of shear stress). Despite these factors, a major role is played by the elasticity of Amaris and by the similar contraction rates with dentine for the RMGC and conventional glassionomer cements. The adhesion and retention rate is lower in the case of compomer Dyract. The colour instability rugous surfaces of RMGC is due to HEMA molecules, water adsorption and dehydration, associated with inferior values of incices Ryge for parameters colour and surface quality. The marginal fractures and the adhesive failures associated with marginal colour are associated with compomer and composite resins restorations after 12-24 months, representing most encountered defects of cervical restorations. Also the marginal adaptation failure represent one of the major reason for the replacement of cervical restorations.

X.5. CONCLUSIONS

- The bioadhesive materials used in restorative therapy of non-cariogenic cervical lesions present retention rates over 90% associated with proper technic, cariogenic risk controle and the elimination of traumatic occlusion;
- After 24 months, RMGC and conventional glassionomer cements present very good clinical performances regarding marginal integrity, marginal coloration, anatomic contour;
- After 24 months, the restorations from microhybride composite resins presented satisfactory results for marginal integrity, marginal coloration and very good results for parameters culour, surface quality, anatomic contour;
- After 24 months, the restorations from compomer associated with self-etch adhesive system, presented poor results regarding marginal integrity and marginal coloration and satisfactory results for surface quality, anatomic contour.
Chapter XI

STUDY FEA REGARDING ETHIOPATOGENIC MECHANISMS OF ABFRATIONS

XI.1. Introduction
The cervical area of teeth can present various categories of lesions related of etiology, structure, clinical expression. The non-cariogenic lesions can appear as single (abruptions, erosions, abrasions) or as complex lesions, produced by numerous etiological factors.

XI.2. Study aims
The FEA study proposed to visualise in tridimensional plan and to calculate the loading and tensions developed at the cervical level while patients exert masticatory functions both for healthy dental structures and direct cervical restorations.

XI.3. Material and methods

The FEA analysis is base on simple principles:
• object modelling (transformation in solid);
• definition of parameters and objects;
• discretisation of model and the establishment of elements (meshing);
• the application of limitations and loadings;
• definition of contacts types;
• solving of equations systems;
• results display (cromatic or alfanumeric).

The method of selection started from the principle that any cervical lesion of dental structures can be a center for the stress concentration and any direct restoration represents an efficient way to ameliorate the distribution of internal stress for teeth with non-cariogenic dental lesions.

The modelling of object was processed in Rhinoceros, Nurbs modeling for Windows, version 4.0 with Intel Core 3i, Windows 2007. It was realised a tridimensional model of mandibular bicup, respecting all morphological features of dental tissues, periodontal ligaments and alveolar processus (fig.51). The thick of periodontal ligaments was 0,3 mm, thick of cortical was 2 mm conform literaturii de specialitate, grosimea corticalei la nivelul coletului dentar de 2 mm. The thick of enamel respected the avergae values: cuspids V – 1,3 mm, O – 1,1; proximal surfaces V – 1,2mm, O – 1,1 mm, M and D – 1,0 mm.
Fig. 51. Tridimensional model of inferior bicups—coronal dentine, pulp room, radicular dentine, enamel, periodontium, alveolar bone

In the first stage of the study, the initiation of abfraction lesion was assessed for a para-functional force of 250 N applied on vestibular surface of inferior bicuspid in 40° angle. Once the abfraction area was localised, the second stage of study focused on the biomechanical behaviour of lesions with different dimensional parameters. The third stage consists in the study focused on direct cervical restorations (amalgam, composite resins, glassionomer cements). Two different types of cervical non-cariogenic lesions were studied. The constants of the models were as follows: periodontal support quantity, distance from gingival margin and alveolar constant and lesion depth. Regarding the types of cervical lesions, the next parameters had different values: forme, volume, angle between gingival and occlusal margins. The non-cariogenic lesions were processed in cervical vestibular areas, related to the highest frequency of these lesions on vestibular surfaces.

XI.4. Results and discussions

The analysis of loading and stress was performed in ANSYS WorkBench. The properties of material accepted for dental structures are Young modulus and Poisson constant, presented in table 18.

Table 18. The Young modulus and Poisson constants

<table>
<thead>
<tr>
<th>Structural</th>
<th>Enamel</th>
<th>Dentine</th>
<th>Corticale</th>
<th>Spongioum</th>
<th>Periodontium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young's Modulus</td>
<td>8,4e+010 Pa</td>
<td>1,67e+010 Pa</td>
<td>1,18e+006 Pa</td>
<td>4,9e+008 Pa</td>
<td>1,18e+006 Pa</td>
</tr>
<tr>
<td>Poisson’s Ratio</td>
<td>0,3</td>
<td>0,31</td>
<td>0,45</td>
<td>0,3</td>
<td>0,45</td>
</tr>
<tr>
<td>Density</td>
<td>2970, kg/m³</td>
<td>2140, kg/m³</td>
<td>0, kg/m³</td>
<td>0, kg/m³</td>
<td>0, kg/m³</td>
</tr>
</tbody>
</table>

The different values for different components of dental, periodontal and bone structures were considered to realise a realistic interfacial tooth-bone.

The masticatory process analysis was performed starting from contact points between antagonist teeth, representing points of functional mechanical loading. The loading was uniform (1N), linear analysis allowing the increasing of stress degree with percents related to the variation of external loading. All materials were considered isotropes with linear constitutive relations.
The stress fields were realised to the level of enamel-cement junction. These stress fields were divided to obtain a detailed network (mesh) that allows very accurate results.

The model was formed by 34364 nodes and 23922 elements. In this study, the fix areas were considered lateral (proximal) surfaces of the modeled block. The forces applied on this block had different values and orientations. The selection of values and orientation was related to diverse studies that showed values of 500 N functional forces recorded to the level of mandibularicusps. If a bruxism is associated these forces can reach 1000 N. Because for a force of 300 N, the tooth movement in alveole can be extended to 0.3 mm. This value was considered superior limite for reversible and physiological changing if the force is applied axial. The study recorded also the effects at cervical level if forces with same value are applied on vestibular surface, because the excentric action can induce tensions that overpass the response capacity of periodontium. The study recorded the development of shear tensions at the cervical level for forces of 50 N, 100 N, 150N and 250 N applied both from occlusal and vestibular directions (fig.52).

Two types of cervical lesions were assessed. The occlusal forces were applied to the next areas: vestibular cuspid, oral cuspid, center of occlusal surface, and stress was monitorised and recorded (fig.53). After the recording and introduction of data the next stage was represented by the solving of differential ecuation systems associated with the studied physical processes.

Fig. 52. Force application

Fig. 53. Visualisation and recording of cervical stress (maximal values).
<table>
<thead>
<tr>
<th>LOADING FORCE (N)</th>
<th>MAXIMAL PRINCIPAL STRESS (MPA)</th>
<th>MOVEMENT (µm)</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Enamel</td>
<td>Dentine</td>
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<tr>
<td>Axial loading</td>
<td></td>
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</tr>
<tr>
<td>300</td>
<td>17,6</td>
<td>0,1</td>
</tr>
<tr>
<td>Para-axial loading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>19,4</td>
<td>3,8</td>
</tr>
<tr>
<td>80</td>
<td>31,1</td>
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<td>7,7</td>
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<td>200</td>
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<td>15,4</td>
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<td>250</td>
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<td>300</td>
<td>151</td>
<td>34</td>
</tr>
<tr>
<td>500</td>
<td>252</td>
<td>38,6</td>
</tr>
</tbody>
</table>

Table 19. Stress values recorded at cervical level related to type of loading

The tensions at cervical level varies between 19,4MPa (enamel), 3,8MPa (dentine) for paraaxial loading of 50 N and 252Mpa(enamel), 34Mpa(dentine) for paraaxial loading of 500N. In case of axial loading of 300N maximal principal stress reaches 17,6Mpa at enamel level and only 0,1Mpa at dentine level.

XI.5. CONCLUSIONS

- For paraaxial solicitations this study proved the suprasolicitation of cervical enamel in the case of paraaxial loading. The severity of stress was influenced by forme, extension and deep of noncariogenic cervical lesion;
- For unrestorated cervical lesions (NCLs), the stress were concentrated to the apex of lesion without relation with its configuration. For the treated cervical lesions (NCLs), were recorded higher values for stress to the level of gingival and occlusal margins, comparing with unrestorated noncervical lesions (NCLs);
- The presence of cervical lesions changed the distribution of stress induced by occlusal loading, and concentrated stress to the apex of noncariogenic lesion;
- The direct restoration of cervical lesions reduced stress concentrated to the apex of noncariogenic lesions (NCLs).
FINAL CONCLUSIONS

- The etiology of dental erosions is multifactorial, our study indicating the importance of nutrition, beverages (coffee, tea, alcohol), medication and systemic disorders as well as gingival recessions.
- The anatomic patterns of JSD are very diverse related to different dental groups and surfaces. The various patterns of JSC and the fragility of this area requires a careful management during therapeutic procedures, explaining the association of cervical dentinal hypersensitivity and sometimes the presence of cervical root resorptions.
- Coca Cola has lowest pH values and acidity, followed (increasing range) by wine, Nestea lemon, Listerine și Corsodyl. All 3 acid beverages and 2 oral mouthwashes determined significant decreases of calcium, phosphor concentrations both for enamel and dentine;
- In experimental conditions created in this study, surface roughness of composite resins was affected both for hibride and microhibride composite resins after immersion in acid environment;
- The bioadhesive materials used in restorative therapy of non-cariogenic cervical lesions present retention rates over 90% associated with proper technic, cariogenic risk control and the elimination of traumatic occlusion. After 24 months, RMGC and conventional glassionomer cements present very good clinical performances regarding marginal integrity, marginal coloration, anatomic contour;
- The tridimensional modeling allows the visualization of tensions induced at the cervical areas of healthy teeth, in the case of different types of occlusal and vestibular loading (application, orientation, intensity);
- For paraaxial solicitations this study proved the suprasolicitation of cervical enamel in the case of paraaxial loading;
- For unrestorated cervical lesions (NCLs), the stress were concentrated to the apex of lesion without relation with its configuration. For the treated cervical lesions (NCLs), were recorded higher values for stress to the level of gingival and occlusal margins, comparing with unrestorated noncervical lesions (NCLs);
- The presence of cervical lesions changed the distribution of stress induced by occlusal loading, and concentrated stress to the apex of noncariogenic lesion;
- The severity of stress was influenced by forme, extension and deep of noncariogenic cervical lesion;
- The direct restoration represents a stress buffer, especially in deep noncariogenic cervical lesions.
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