การศึกษาเปรียบเทียบผลิตภัณฑ์คืนกลับแร่ธาตุสามชนิด ในการเปลี่ยนแปลงรอยโรคจุดขาวของผิวเคลือบฟันในห้องปฏิบัติการ

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COMPARATIVE STUDY OF THREE REMINERALIZING PRODUCTS ON CHANGING THE ENAMEL WHITE SPOT LESION IN VITRO

Miss Pimsiri Kanpittaya

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Orthodontics
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Faculty of Dentistry
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Thesis Title	COMPARATIVE STUDY OF THREE REMINERALIZING PRODUCTS ON CHANGING THE ENAMEL WHITE SPOT LESION IN VITRO.
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Field of Study	Orthodontics
Thesis Advisor	Associate Professor Porntip Chiewcharat

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พิมพ์สิริ กันต์พิทยา : การศึกษาเปรียบเทียบผลิตภัณฑ์คืนกลับแร่ธาตุสามชนิด ในการเปลี่ยนแปลงรอยโรคจุดขาวของผิวเคลือบฟันในห้องปฏิบัติการ (COMPARATIVE STUDY OF THREE REMINERALIZING PRODUCTS ON CHANGING THE ENAMEL WHITE SPOT LESION IN VITRO) อ. ที่ปรึกษาวิทยานิพนธ์หลัก : รศ.ทญ. พรทิพย์ ชิวชรัตน์, 90 หน้า.

วัตถุประสงค์ : เพื่อเปรียบเทียบลักษณะที่มองเห็นได้ของรอยโรคจุดขาว ก่อนและหลังการแทรกแซงด้วยผลิตภัณฑ์คืนกลับแร่ธาตุสามชนิดและใช้โปรแกรมวิเคราะห์ภาพด้วยคอมพิวเตอร์ประเมินว่าชนิดใดมีความสามารถสูงสุด

วัสดุและวิธีการ : นำส่วนตัวฟันของมนุษย์เก้าสิบซี่ มาทาด้วยน้ำยาเคลือบฟัน เหลือช่องขนาดเล็กของผิวเคลือบฟันปกติไว้ในแนวขนานพื้นราบ จากนั้นสร้างรอยโรคจุดขาวจำลองขึ้นบนผิวเคลือบฟันปกติ โดยแช่ในสารละลายแร่ธาตุสามสิบนาที แบ่งชิ้นงานตัวอย่างออกเป็นสามกลุ่มโดยสุ่ม เพื่อเข้าสู่การแทรกแซงด้วยผลิตภัณฑ์คืนกลับแร่ธาตุสามชนิด คือ กลุ่มเอ (GC tooth mousse) กลุ่มบี (Clinpro™ tooth crème) และกลุ่มซี (Prevident®) ทั้งหมดถูกนำเข้าสู่วงจรการสูญเสียและคืนกลับแร่ธาตุหกสิบวงจร ถ่ายภาพชิ้นงานตัวอย่างโดยผิวเคลือบฟันทำมุมสิบห้าองศากับกล้องถ่ายภาพ นำภาพมาวิเคราะห์ภาพด้วยโปรแกรมคอมพิวเตอร์ และบันทึกในรูปของสัดส่วนความเข้มแสง LI% (luminance intensity proportionality) เพื่อประเมินลักษณะที่มองเห็นได้ของรอยโรคจุดขาว

ผลการทดลอง : ค่าสถิติที่ระดับความเชื่อมั่นร้อยละ 99 แสดงให้เห็นว่าสัดส่วนความเข้มแสงของรอยโรคจุดขาวก่อนและหลังการแทรกแซงด้วยผลิตภัณฑ์คืนกลับแร่ธาตุแตกต่างกันอย่างมีนัยสำคัญ ($p<0.001$) ทั้งสามกลุ่ม และค่าสถิติที่ระดับความเชื่อมั่นร้อยละ 95 แสดงความเปลี่ยนแปลงของสัดส่วนความเข้มแสงระหว่างกลุ่มเอ/กลุ่มซี และ กลุ่มบี/กลุ่มซี ว่าแตกต่างกันอย่างมีนัยสำคัญ ($p<0.050$) ในขณะที่ระหว่างกลุ่มเอ/กลุ่มบี ไม่แตกต่างกัน ($p=1.000$).

สรุปผลการทดลอง : ลักษณะที่มองเห็นได้ของรอยโรคจุดขาวลดลงหลักจากใช้ผลิตภัณฑ์คืนกลับแร่ธาตุทั้งสามชนิด โดยกลุ่มซี (Prevident®) ให้ผลความเปลี่ยนแปลงต่อรอยโรคจุดขาวมากที่สุด

ภาควิชา ทันตกรรมจัดฟัน ลายมือชื่อนิสิต .....

สาขาวิชา ทันตกรรมจัดฟัน ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก .....

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5376124432 : MAJOR ORTHODONTICS

KEYWORDS: WHITE SPOT LESION / REMINERALIZING PRODUCT / OPTICAL CHANGE

PIMSIRI KANPITTAYA : COMPARATIVE STUDY OF THREE REMINERALIZING PRODUCTS ON CHANGING ENAMEL WHITE SPOT LESION. ADVISOR : ASSOC. PROF. PORNTIP CHIEWCHARAT, 90 pp.

Objective: To compare optical appearance of white spot lesion before and after intervention with three remineralizing products and determine which one has the highest potency by using computerized image analysis.

Materials and methods: Ninety human tooth crowns were coated with an acid resistant varnish, leaving a small window of sound enamel parallel to the horizontal plane. Artificial white spot lesion was created by thirty minutes immersion in demineralizing solution. Samples were randomly allocated into 3 groups : group A (GC tooth mousse : Casein Phosphopeptide - Amorphous Calcium Phosphate), group B (Clinpro tooth crème : 0.21% w/w sodium fluoride anti-cavity paste with tri-calcium phosphate) and group C (Prevident : 1.1% w/v Sodium Fluoride) are subjected to 60 remin/demin cycles. Photographs of each sample before and after intervention were taken at fifteen degree angle to the enamel surface and analyzed using computerized image analysis. Data was measured in term of LI% (luminance intensity proportionality) for optical appearance measurement.

Results: Paired t-test showed that LI% before and after intervention of three groups were significantly different ($p<0.001$) at 99% confidence level. One-way ANOVA and Bonferroni statistics showed that changed LI% comparing between group A/ group C and group B/ group C were significantly different ($p<0.050$) while group A/ group B was not significantly different ($p=1.000$) at 95% confidence level.

Conclusion: Optical appearance of white spot lesion was decreased after applied three remineralizing products and group C (Prevident : 1.1% w/v Sodium Fluoride) represented the highest change on white spot lesion.

Department : Orthodontics Student's Signature .....

Field of Study : Orthodontics Advisor's Signature .....

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CHAPTER I

INTRODUCTION

Background and Rationale

White spot lesion is one of undesirable complications, occurred on enamel surfaces during fixed orthodontic treatment, especially in the poor oral hygiene patients. [1, 2] Orthodontic patients experience difficulty in brushing teeth from the beginning of treatment due to increasing of plaque retention site. Acidogenic bacterium in plaque cause low pH and lead to imbalance between demineralization and remineralization. When remineralization is overcome, white spot lesion takes place. [1, 3, 4]

Optical appearance of the lesion comes from changing of difference between refractive index of sound and abnormal enamel. When the light reflection differs, the lesion can be seen as white spot and it may compromise the esthetics of patient's smile. [5]

Nowadays, various products release and claim to have remineralizing potential. Thus many evaluating processes come up to measure white spot lesion both macroscopically and microscopically depend on purpose of application.

Various investigations in vitro and in vivo have shown effect of remineralizing agents on white spot lesion measured by subsurface remineralization, lesion depth, mineral content, surface microhardness and fluoride uptake, for instance. [6-11] However, few studies demonstrate optical properties change, a factor that patient might concern about more than molecular change of the lesion.

Fortunately, another interesting method in defining enamel demineralization by using photographic technique with computerized image analysis, was proposed. Researchers have shown that under controlled circumstances and appropriate camera angle, this method is not only reproducible but also cheap and accessible. [12-16]

Hence, comparison of white spot lesion change after each remineralizing agent application would be useful for patient as another consideration in choosing appropriate product. Aim of this study is to compare white spot lesion before and after intervention

with three remineralizing products and determine which one has the highest change on the lesion with computerized image analysis.

Research Questions

1. Does the white spot lesion area (LI%) after applying each of remineralizing product differ from before using it?
2. Does the white spot lesion area changed (changed LI%) of three remineralizing products different?

Objectives

1. To compare the white spot lesion area (LI%) before and after the intervention with each of remineralizing product determined by computerized image analysis.
2. To compare the white spot lesion area changed (changed LI%) among three remineralizing products determined by computerized image analysis.

Research Hypotheses

1. The white spot lesion area (LI%) before and after intervention with each of remineralizing product is different.
2. The white spot lesion area changed (changed LI%) of three remineralizing products are different.

Assumptions

1. This research is an experimental study in vitro using extracted human teeth as samples.
2. White spot lesion is artificially produced to imitate optical appearance of post-orthodontic demineralization.
3. Remineralizing products used in this study are as followed
    - GC tooth mousse (CPP - ACP : Casein Phosphopeptide - Amorphous Calcium Phosphate)

- Clinpro™ Tooth Crème (0.21% w/w Sodium Fluoride Anti-Cavity Paste with Tri-Calcium Phosphate)
- Colgate® Prevident® Gel (1.1% w/v Sodium Fluoride)

4. All samples are in the same remin-demin cycle during experiment except intervention that follows each product instruction.
5. Position of demineralized area on tooth surface is set up for standardized photograph, paralleling to the horizontal plane in all samples.
6. Photographs of all samples are taken with DSLR (Digital single-lens reflex) camera under controlled light environment.
7. Distance between image receptor (in the camera) and the object is kept constantly with camera holder while macro lens can be adjusted to focus the object.
8. White spot lesion is measured by computerized image analysis in terms of surface area (Mean gray scale) and calculated into LI% to be analyzed in this study.
9. Only one researcher is responsible for taking a photograph and analyzing the image on the computer in this study. The researcher is well trained and repeatability test is applied.

Limitations

1. This research is an experimental study in vitro. Remin/demin cycle does not imitate actual situation in oral activity such as saliva, plaque, bacteria, diet and temperature that may affect concentration, mineral content and pH of remineralizing products therefore results of this study cannot refer to actual clinical results.
2. Photographs are taken in dry setting at room temperature different from actual situation in oral cavity such as moisture, saliva, gingiva, light reflection from adjacent teeth, measurement from these photographs may not be able to refer to actual situation in oral environment.

3. Due to different remineralizing products, method of application and amount of agent are varies following their instructions, in order to resemble the consumer's usage. In this study, numbers of remin/demin cycles for all groups are controlled.

Operational Definitions

In this study, surface area was defined as mean gray scale ranges from 0 (black) to 256 (white) and measurement value is luminance intensity proportionality (LI%)

$$\text{LI\% (luminance intensity proportionality)} = \left(\left(\frac{\text{mean gray level of white lesion}}{\text{mean gray level of sound enamel}}\right) - 1\right) \times 100$$

Expected Benefits and Applications

This study will provide beneficial information for upcoming studies as clinical trial and for being a consideration to choose the remineralizing products as a conservative treatment for white spot lesions. Visual property of white spot lesion can obviously be seen by naked eyes and measured by computer program so that it is an objective change to the patient more than microscopic change.

Research Design

A cross-sectional experimental study in vitro.

Obstacles and strategies

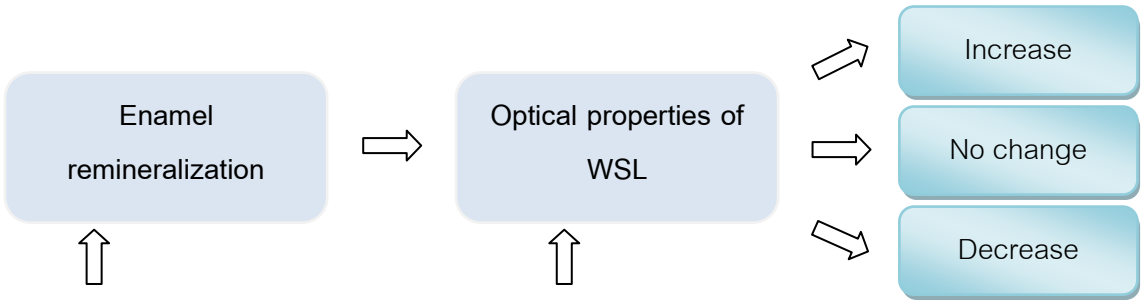
1. Error in photograph taking

   Camera holder is used to set the position of the camera and the distance between image receptor and the object. The sample is placed on the index prepared for reproducibility of the sample's position.

2. Exhaustion of the operator

   A break is including in the working schedule.

Conceptual Framework



- Duration of product application
- Method of application
- Type of product
- pH of product
- Environment
  example : remin/demin cycle, fluoride

- Camera
- Lighting : environment, flash
- Angle bet ween camera and enamel surface
- Sample position
- Analyzing program

Chapter II

LITERATURE REVIEW

Literature Review

- **White spot lesion**

Longbottom et al. [17] defined white-spot lesion as a carious lesion where the net subsurface mineral loss has produced changes in optical properties of enamel such that these are visibly detectable as a loss of translucency, resulting in a white appearance of enamel surface. They also described demineralization as the loss of calcified material from the structure of the tooth and remineralization as the net gain of calcified material within the tooth structure, replacing that was previously lost by demineralization.

White opacities appeared on enamel surface occurred as consequence of numeral factors. Due to different causes, lesion can be classified into these following [18]

1. Pre-eruptive enamel opacities

   These defects can be caused by localized or generalized factor so that enamel defects present on a single tooth or the whole dentition. Failure of enamel formation may arise from excessive fluoride uptake, infection, trauma, systemic disorders and so on. Their severity is varied. [19] Discoloration is usually white or yellowish with poor defined border and may have symmetrical distribution. [20]

2. Post-eruptive enamel opacities

   These defects are resulting from enamel demineralization. Demineralization can be occurred from numerous factors such as microbial factors, salivary flow rate, salivary pH and buffer capacity, oral hygiene, diet and fixed oral appliances. [1]

- **White spot lesion in orthodontics and its optical properties**

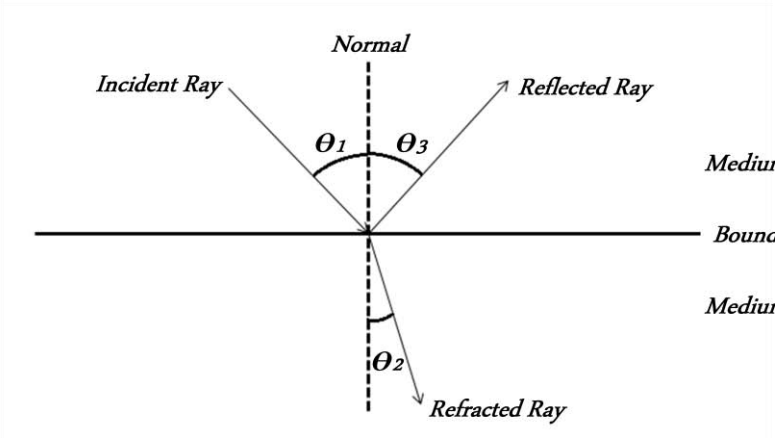
In orthodontic treatment, fixed appliances produce greater amount of plaque retention sites which are hard for patients to maintain their oral hygiene. Owing to increasing of plaque volume and elevation of acid producing bacteria, pH level decreases and finally decalcification occurs. [1, 3]

When white spot lesion takes place, an enamel porosity from demineralization shows a white opacity on enamel surface. As enamel translucence depends on mineral content in tooth material, white spot can be seen while lost mineral content is replaced by water so that changing of refractive index difference between sound and affected enamel causes larger light backscatter in demineralization area. [5, 21]

- **Reflection and Refraction** [22, 23]

When the light rays encounter a change in the medium, they change their direction. The change can be a gradual one, as when the light travels through air of various density, or it can be abrupt, as the light strikes the boundary between two different substances. The situation is shown in Fig.1.

Figure 1 Reflection and refraction between two substances



There are two effects taking place at the margin between two substances. The incident ray is split into two rays : one bounces back into the first medium in a changed direction and is called the reflected ray, the other continues into the second medium in a changed direction and is called the refracted ray. Angles are measured from the normal

(perpendicular line) to the surface at the point of incidence. An angle of incidence θ_1 is between the incidence ray and the normal. An angle of reflection θ_3 is between the reflected ray and the normal. Lastly, an angle of refraction θ_2 is between the refracted ray and the normal. What fractions of the incidence light appear in the refracted and reflected rays are determined by the nature of two media and the angle of incidence. Generally, the greater the angle of incidence, the greater is the proportion of the reflected light.

1. Reflection

In reflection, a simple rule governs the ray behavior : The angle of reflection equals the angle of incidence. This can be written in $\theta_1 = \theta_3$ referring to the symbols of Fig.1.

2. Refraction

The phenomenon of refraction is more complicated than reflection due to the angle of refraction depends not only on the angle of incidence but also on the nature of the two media involved. In particular, refraction depends on a quantity, defined for each medium, called index of refraction. The index of refraction for any medium is defined as a ratio of the speed of light (c) in a vacuum to the speed of light (v) in the medium while (n) is an index of refraction.

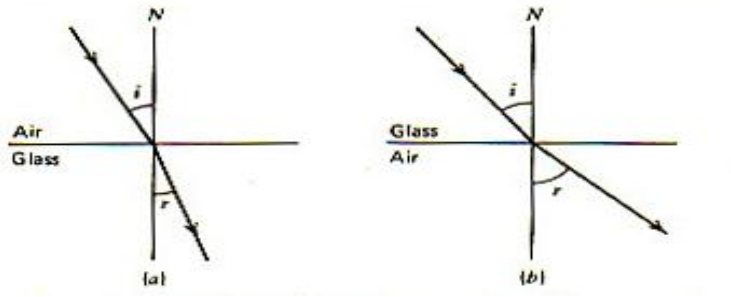
$$n = \frac{c}{v}$$

The index of refraction is a constant for a given material and is tabulated in many reference books. Since refractive index is related inversely to the speed of light in the medium, light must travel more slowly in denser medium. In conclusion, denser materials have higher indices of refraction.

The law of refraction can be stated in terms of the angles of incidence and refraction and the refractive indices of the two media involved. There are two possible situations : (1) when light moves from one medium to another of higher index of refraction it bends toward the normal and (2) when light moves

from one medium to another of a lower index of refraction it bends away from the normal. (Fig.2)

Figure 2 Law of refraction



In conclusion, the proportions of reflected and refracted light depend on the nature of the two media and it can be stated that they depend on the two refractive indices. The more nearly equal the two indices, the less light is reflected. If the two media have the same index of refraction, then no light is reflected, the angle of refraction equals the angle of incidence, and as far as the light is concerned, there is no boundary. As mentioned above that white spot lesion can be seen from difference refractive index between sound and abnormal enamel of the demineralizing area.

- **Measurement of white spot lesion**

1. Photographic technique

Optical change of white spot lesion can represent degree of altered mineral content; as a result, it was used to measure outcome of products and interventions. Macroscopic properties were evaluated by various methods such as visual inspection (clinical examination), light scattering, laser and quantitative light induced fluorescence (QLF). Another interesting method is photographic technique, since camera is commonly used in clinical examination, this method provides many advantages. It is convenient, cost efficient and gives a permanent record. However, there are several factors that have to be

controlled in this procedure. For example, light condition, light reflection and slanting of the camera all affected photographs.[5] From these problems, researchers have been studying to create reproducibility and validity of photographic technique for evaluation of enamel demineralization.

Benson et al.[12] found that the photographic technique was a reproducible method of measuring artificial enamel demineralization and more reproducible than direct measurement with the naked eye or vernier callipers. But they suggested production of film based image may produce variation in longitudinal study that optical changes in enamel surface might be misinterpreted. Besides appropriate camera angle and index need to be investigated in further study.

Benson et al. [14] investigated appropriate camera angle for photographic technique and concluded that suitable angle is tilting the camera no more than 20 degree to the perpendicular of the tooth surface.

2. Computerized image analysis

By converting captured slides to digital images [13, 14, 18], Benson et al. [14] and Willmot et al. [16] proposed computerized image analysis as a reproducible method to measure area of demineralization. They recommended that reliable photograph should be taken at proper angle with flash masking nearest to the tooth surface to inhibit reflections.

They [13] quantified white lesions with gray scale level ranged between 0 (black) and 256 (white) while Kanthathas et al. [18] used Luminance intensity proportionality (LI%). Luminance intensity proportionality is defined as the white lesion gray level as a percentage of the sound enamel gray level calculated from :

$$\text{LI\% (luminance intensity proportionality)} = \left(\left(\frac{\text{mean gray level of white}}{\text{mean gray level of sound enamel}} \right) - 1 \right) \times 100$$

They suggested that using proportions instead of absolute gray scale was beneficial for removing calibration device on the image. Because extra step might bring in additional error to the method.

As mentioned previously, errors may come up from image processing therefore Benson et al.[24] demonstrated assessment demineralized white lesions on enamel of images from digital camera to be accurate and reproducible as from captured slide. In this study, they measured the absolute area of demineralization ($mm.^2$) and the mean gray level in term of proportion as in Kanthathas et al.'s study.

Benson's study [25] in vitro found that computerized image analysis was reproducible. In another study [26], they found that it was less reliable comparing to QLF (quantitative light-induced fluorescence) method. For computerized image analysis, negative predictive value was valid and reliable while positive predictive value was less reliable. The false positives were discussed to be occurred from flash reflection. Nevertheless, in 2009 there were the researchers [14, 27] who used image analysis for quantifying white spot lesions and insisted its reproducibility and reliability under controlled circumstances that the angle of the camera was not exceeding 20 degree from perpendicular plane as mention in the previous studies.

- **Remineralizing products**

1. Sodium fluoride

Pulido et al. demonstrated that sodium fluoride had a potential to inhibit demineralization of enamel. [28] As well as Lynch et al. who reported the effect of sodium fluoride in increasing hardness of non-cavitated carious lesion. [29, 30]

2. Casein Phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP)

Casein phosphopeptides (CPP) is the sequence of -Ser(P)-Ser(P)-Ser(P)-Glu-Glu while Amorphous Calcium Phosphate (ACP) is [$Ca_3(PO_4)_2 – nH_2O$]. CPP is able to stabilize calcium phosphate in CPP-ACP complex which has the bonding ability to the tooth surface after application resulting in high concentration of ACP deposition to the tooth surface. It should be led to the following consequences ; [6, 8]

- Buffering the free calcium and phosphate ions by amount of localized CPP-ACP thus increasing salivary buffering effect.
- The level of calcium phosphate in plaque increases.
- Supersaturation of calcium phosphate.
- Inhibiting enamel demineralization.
- Enhancing enamel remineralization.

Fluoride ions could promote the formation of fluoroapatite in the presence of the calcium and phosphate ions which were produced during demineralization of tooth enamel. One unit of fluoroapatite could be developed in the presence of 2 fluoride ions, 10 calcium ions and 6 phosphate ions.

CPP-ACP has been recommended by various studies for the treatment of white lesions. [9, 16] Bailey et al. demonstrated that a remineralizing agent containing CPP-ACP enhanced regression of white spot lesion comparing with an identical agent not containing CPP-ACP. [9] If calcium and phosphate ions were available sufficiently, application of fluoride can promote enamel remineralization. Reynolds et al. showed that not only did CPP increased fluoride incorporation into dental plaque, but it also improved incorporation of fluoride into subsurface enamel and substantially increased subsurface remineralization compared with fluoride alone. [31]

3. Sodium Fluoride with functionalized Tri-calcium phosphate

There was an attempt to combine other minerals with fluoride without sacrificing fluoride availability. Since then calcium and phosphate were added in different forms to find the best formula that provides synergistic effects thus fluoride availability is still excellently maintained. Tri-calcium phosphate has been reported as a functionalized calcium phosphate. [32] It could be mixed with fluoride, not only to boost up fluoride remineralizing property but also to avoid compromising fluoride availability. Karlinsey et al. stated that combination of functionalized calcium phosphate with NaF presented greater remineralization in terms of surface microhardness and enamel fluoride uptake as it helps promoting mineral nucleation in demineralization. [11, 33, 34]

- **Acid resistant varnish**

Nail polish is used as an acid resistant varnish in the experiment. It composed with two major types of ingredients which are as followed ;

1. Organic solvents

This part is responsible for dissolution of hardening agent while the solution kept in the bottle. After applying a nail polish, organic solvents evaporate and hardening agents set consequently.

Example : Ethyl acetate, Isopropyl alcohol.

2. Hardening agents

When the organic solvents evaporate, hardening agents deposit as a thin film on the applied surface. These hardening agents are basically types of plastics such as nitrocellulose and copolymer. They are only soluble in acetone therefore acid or alcohol mixtures cannot dissolve them.

Acid resistant varnish is used to prevent enamel from acid reaction during experiment. As it is not dissolve in any solvents but acetone, its contamination is not interfering the results.

Chapter III

RESEARCH METHODOLOGY

Population

Enamel surface of human permanent teeth.

Sample size

This study contains two hypotheses that would be tested with different statistics, therefore sample size estimation for both would be demonstrated.

1. The white spot lesion area after intervention with each remineralizing product is different from initial lesion. Measurement value is LI%, comparing between before and after intervention.
    - Sample size estimation formula for testing mean of two dependent populations.

$$n = \frac{\sigma^2 (Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

$$\boxed{\sigma^2 = \sigma_1^2 + \sigma_2^2 - 2r\sigma_1\sigma_2}$$

2. The white spot lesion area changed of three remineralizing products are different. Measurement value is LI% difference between before and after intervention of each remineralizing products.
    - Sample size estimation formula for testing mean of two independent populations.

$$n = \frac{2\sigma^2 (Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

From pilot study which there were 5 samples in each group, mean and standard deviation, recorded for the calculation of sample size, are shown in the table 1 and table 2 for dependent and independent sample respectively.

Table 1 Sample size : Dependent sample

	Sample group	μ_1	S_1	μ_2	S_2	$Z_{1-\alpha/2}$	$Z_{1-\beta}$	r	Sample size
Dependent sample	Prevident : Before / After	5.90967	4.95156	7.09100	4.90754	1.96	1.282	0.975	366.05
	GC : Before / After	6.08200	4.48124	6.99733	4.46549	1.96	1.282	1.000	502.08
	Clinpro : Before / After	6.25633	3.58641	5.34667	3.42312	1.96	1.282	0.443	312.21

Table 2 Sample size : Independent sample

	Sample group	μ_1	S_1	μ_2	S_2	σ^2	$Z_{1-\alpha/2}$	$Z_{1-\beta}$	Sample size
Independent sample	Prevident and GC	2.95733	1.72812	3.23067	1.99029	3.47384	1.96	0.842	730.11
	Prevident and Clinpro	2.95733	1.72812	4.97600	2.44349	4.47854	1.96	0.842	17.26
	GC and Clinpro	3.23066	1.99029	4.97600	2.44349	4.96597	1.96	0.842	25.60

Data in the table is calculated that the sample size in each independent group is 731 which is the highest value thus total sample for 3 groups would be 2,193. The sample size is set at 30 samples per group which would be totally 90 samples, because of the limitation in the budget, working time and sample accumulation, moreover, 30 is the minimum amount that normal distribution of the data would be possible to be generated.

Sample

90 extracted human permanent teeth. There are anterior teeth, canines, premolars and molars in all groups as shown in table 3.

1. Inclusion criteria

1.1 Macroscopically free of stains, caries, enamel defects (white spot lesions) and restorations.

1.2 The patients were informed about the research information and allowed the researcher to obtain their teeth as samples.

Table 3 Number of anterior teeth, canines, premolars and molars in each group

Tooth	Group A	Group B	Group C	Total
Anterior	8	8	8	24
Canine	2	2	2	6
Premolar	15	15	15	45
Molar	5	5	5	15
Total	30	30	30	90

Variables

- Independent variables : Remineralizing products
- Dependent variables : Surface area of white spot lesion (Luminance Intensity Proportionality : LI%)

Research equipments

1. Camera and components

- Camera : Canon EOS D500 with a Canon EFS 60mm f/2.8 Macro lens
- Ring flash : Canon Macro Ring Lite MR-14EX
- 2A Batteries and Charger

2. Camera setting's equipments

- Camera holder
- 15 degree tilted platform
- 18% Gray card (Kodak, Made in Japan)

3. Sample preparation's equipments

- Distilled water
- Plastic tube
- Plaster stone
- Orthodontic brackets
  (Standard Edgewise Kit 0.018 / mini dyna-lock™ / 3M Unitek)
- Rectangular wire : 0.018" x 0.025" Stainless steel wire
- Elastomeric ring (Color : Black, Dynaflex, Made in USA)
- Silicone glue
- Glue gun
- Blade with blade holder
- Acid resistant varnish
- Ligature cutter
- Ligature wire
- Mathieu needle holder

4. Intervention equipments and solution

- GC tooth mousse (Vanilla flavour)
- Clinpro™ Tooth Crème
- Colgate® Prevident® Gel
- Deionized water
- Demineralizing solution
  - Lactic acid / Sodium hydroxide
- pH meter (Orion, Model 420A) with Electrode (Thermo)
- Artificial saliva (Non-fluoride formula)
- Orbital shaker incubator (STUART SCIENTIFIC, Model SI 50, Made in UK)
- Sample's container for intervention

Research equipments are from figure 3 to figure 17

Figure 3 Camera and components

Figure 4 Camera setting's equipments

Figure 5 Sample preparation's equipments : plastic tube

Figure 6 Sample preparation's equipments : orthodontic bracket

Figure 7 Sample preparation's equipments : elastomeric ring

Figure 8 Sample preparation's equipments : glue gun with silicone glue

Figure 9 Sample preparation's equipments : Mathieu needle holder, ligature cutter and ligature wire

Figure 10 Intervention equipments and solution : GC tooth mousse

Figure 11 Intervention equipments and solution : Clinpro™ Tooth Crème

Figure 12 Intervention equipments and solution : Colgate® Prevident® Gel

Figure 13 Intervention equipments and solution : pH meter with electrode

Figure 14 Intervention equipments and solution : artificial saliva

Figure 15 Intervention equipments and solution : orbital shaker incubator

Figure 16 Sample's container (two separated pieces)

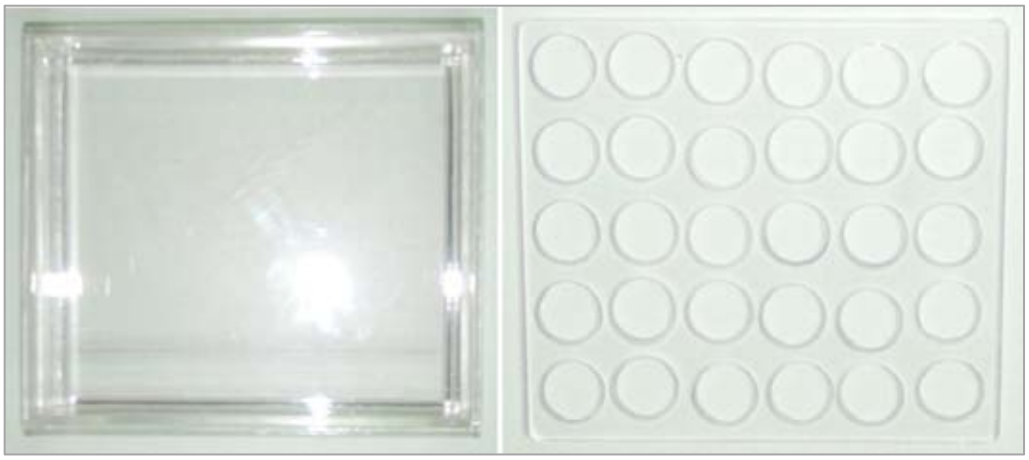
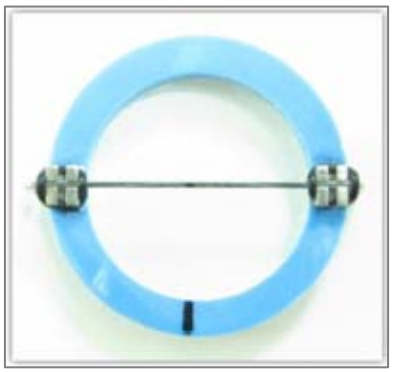


Figure 17 Container with plate

Methodology

1. Sample preparation (positioning of samples)
    1.1 All teeth are kept in distilled water before sample preparation.
    1.2 Root of each tooth is cut at the cement-enamel junction by using diamond wheel. The teeth are pumiced with slow-speed handpiece (3,000 rpm.) for 30 seconds, rinsed with distilled water for 10 seconds and dried with compressed air for 10 seconds.
    1.3 Bracket (Standard Edgewise Kit 0.018 / mini dyna-lock™ / 3M Unitek), which the slot is parallel to the base of the bracket, is adhered closely to smooth surface of the crown with silicone glue. Excessive glue is removed from margins of the bracket with blade. Silicone glue is used to prevent alteration of enamel surface on bracket removal.
    1.4 Prepared crown is ligated to index A (Fig.18) with ligature wire at marked point (on the center) and placed on plastic tube. Crown is embedded in the plastic tube at the settled position.

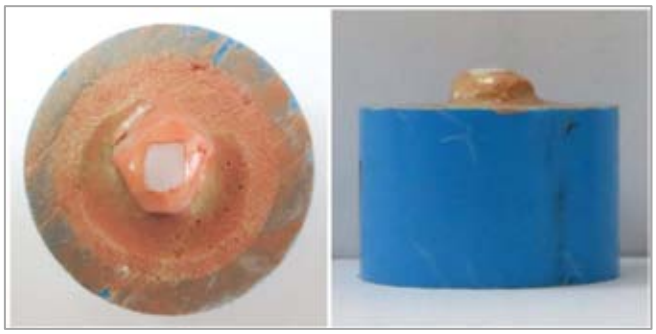
Figure 18 Index A : Use for crown ligation before embedded into plastic tube



    1.5 Ligature wire is removed from the crown with Mathieu needle holder.
    1.6 The prepared crown embedded in plastic tube is coated with acid resistant varnish.
    1.7 Remove bracket with bracket remover.
    1.8 After removal of bracket, the small window is left on smooth surface of

the crown. The window is approximately parallel to the horizontal plane and positioned at the center of plastic tube. (Fig.19)

Figure 19 Prepared sample



1.9 All prepared sample is randomly numbered from 1 to 90 and kept in deionized water (DI water) before photograph taking.

2. Camera settings

2.1 Camera is mounted to the camera holder. The plastic tube (with embedded tooth) is placed on marked position of the 15 degree tilted platform while photograph is taken. An 18% gray card is placed next to the sample as a calibration measurement in image analysis program.

2.2 Photographs are taken using a Canon EOS D500 with a Canon EFS 60 mm f/2.8 Macro lens and a Canon Macro Ring Lite MR-14EX.

2.3 Camera and ring flash settings are as followed ;

- In manual mode with an aperture of f22 and shutter speed of 1/125.
- Magnification 1:1
- Image size : 4752 x 3168 pixels (15 megapixels)
- ISO 100
- Ring flash is set to M1/4 to reduce reflections from the object.
- All four Batteries for ring flash are replaced after 120 flash-counts at the same time as recommended on the instruction manual. [35]
- White balance is calibrated with 18% gray card before photograph taking.

2.4 Macro lens can be adjusted to focus the object because the distance between image receptor (in the camera) and the object is kept constantly with the camera holder.

2.5 To standardize the photographic procedure in relation to the distance and the camera to tooth angle, camera settings are constructed. (Fig.20)

Figure 20 Camera settings

3. Photograph taking

3.1 Sample is removed from the DI water, dried with compressed air for 15 seconds, photograph taken and replaced in the DI water.

3.2 Images of enamel are taken on 15 degree tilted angle to the camera, [14, 27] focusing at the center of an artificial white spot lesion, and all images are saved as TIFF (Tagged Image File Format) file.

Note : Images of the samples before artificial demineralization are kept as a baseline.

4. Artificial demineralization

4.1 The crowns are immersed in demineralizing solution (pH 2.2) for 30 minutes at 37°C to produce an artificial white spot lesion.

4.2 Rinse with DI water for 10 seconds.

5. Camera setting and photograph taking

   5.1 Step 2 and 3 are repeated.

   5.2 All samples are randomly allocated into 3 groups.

   Each group contains 30 samples.

6. Computerized image analysis

   6.1 All images are converted into grayscale images (8-bit range) in Photoshop Element 8.0 and opened in an image analysis program (Image Pro Plus Version 3.0).

   6.2 Gridline and ruler were set to be shown on all images to ease the position repeatability in measuring each image.

   6.3 The intensity is measured at 5 positions at the center of each image relating to the gridline and ruler from previous step and averaged for the mean gray scale of each image (range from 0-256).

   6.4 Mean gray scale is an ordinal scale that cannot be analyzed with parametric statistics, consequently the data were calculated into LI%, which is a ratio scale, for each image.

   6.5 After 2 weeks the images were random, re-measured and calculated into LI% to test the examiner repeatability.

7. Intervention

   7.1 Remin/demin cycle : each cycle contains

      7.1.1 *Treatment intervention*** ; depend on each group.

      7.1.2 Acid challenge (pH 5.0) for 15 minutes at 37°C in an incubator after applying remineralizing agent.

      7.1.3 Between these events all sample are immersed in artificial saliva (pH 7.0) at 37°C in an incubator.

   Remin/demin cycle are performed in an orbital shaking incubator at 37°C.

*Treatment intervention***

Group A : GC tooth mousse (CPP - ACP : Casein Phosphopeptide - Amorphous Calcium Phosphate)

- Placed group A's sample (30 samples) upside down on the container's plate.
- Put it into container filled with remineralizing agent undisturbed for 35 minutes and rinsed with DI water to remove all visible agent.
- Use twice per cycle.

Group B : Clinpro™ tooth crème (0.21% w/w sodium fluoride anti-cavity paste with tri-calcium phosphate)

- Placed group B's sample (30 samples) upside down on the container's plate.
- Put it into container filled with remineralizing agent undisturbed for 2 minutes and rinsed with DI water to remove all visible agent.
- Use twice per cycle.

Group C : Colgate® Prevident® Gel (1.1% w/v Sodium Fluoride)

- Placed group B's sample (30 samples) upside down on the container's plate.
- Put it into container filled with remineralizing agent undisturbed for 31 minutes and rinsed with DI water to remove all visible agent.
- Use once per cycle.

After completion of 60 cycles, all samples are kept in DI water.

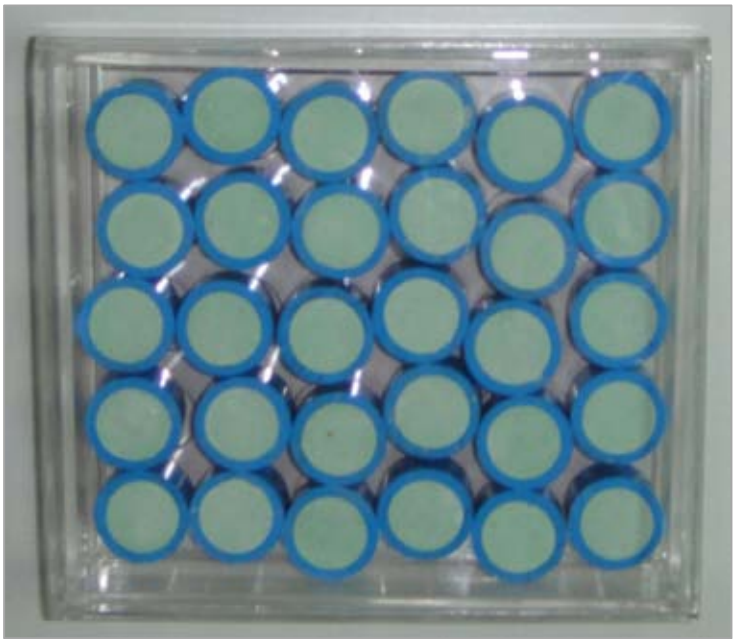
Remarks

- Sample's container was designed to load all 30 samples of each group at a time (upside down position as in figure 21) as it was a step inside each container to put the container's plate on and left the

enamel surface of the sample about 3 mm. far from the bottom of container where solution was filled , so that all enamel surfaces were embedded into the solution at the same time to avoid error of time counting in the intervention cycle.

- There are three containers for each group to contain remineralizing product, acid solution and artificial saliva.
- The remineralizing product in each treatment intervention, acid solution and artificial saliva were changed every time after immersed by the samples, to ensure original concentration of the solution before their use.

Figure 21 Samples were placed upside down in the container



8. Photographic technique
    8.1 Procedures were described previously.
    8.2 All samples are photograph taken.
9. Computerized image analysis
    9.1 Remin/demin cycle : each cycle contains

9.2 Procedures were described previously.

All samples are measured blindly from group defining.

Data collection

Data were collected in term of LI% to test the intra-examiner repeatability and compare white spot lesion before and after intervention. In order to compare white spot lesion change among three remineralizing products, LI% after intervention was minused with LI% before intervention for change LI%.

Data were collected in table 4 and table 5 as follow ;

Table 4 Table for Intra-examiner repeatability analysis data

No.	1 st measurement																			
	Initial						Before intervention							After intervention						
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
...																				
90																				

Table 4 Table for Intra-examiner repeatability analysis data (continued)

No.	2 nd measurement																			
	Initial						Before intervention							After intervention						
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
…																				
90																				

Table 5 Table for Experimental data

No.	Group	Initial						Before intervention							After intervention							Changed LI%
		Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%	
		1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th			
1																						
2																						
3																						
4																						
5																						
6																						
7																						
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9																						
10																						
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90																						

Statistical analysis

1. Intra-examiner repeatability analysis data
    1.1 The data are tested for normal distribution with Kolmogorov-Smirnov test to determine if parametric or non-parametric statistics is suitable.
    1.2 The data of the first and second measurement (2 weeks apart) are analyzed with paired t-test (parametric statistics) or Wilcoxon sign rank (non-parametric statistics) and correlation test to show intra-examiner repeatability.

Note : All statistics are tested at 99% confidence intervals.

2. Experimental Data
    2.1 The LI% of all samples in each group (before and after intervention) are tested separately for normal distribution with Kolmogorov-Smirnov test to determine if parametric or non-parametric statistics is suitable.
    2.2 The LI% of white spot lesion before and after intervention of each remineralizing product will be analyzed with paired t-test (parametric statistics) or Wilcoxon sign rank (non-parametric statistics).
    2.3 The changed LI% of three remineralizing products are tested separately for normal distribution with Kolmogorov-Smirnov test to determine if parametric or non-parametric statistics is suitable.
    2.4 The changed LI% of three remineralizing products will be analyzed with one-way ANOVA (parametric statistics) or Kruskal-Wallis. (non-parametric statistics)

Note : All statistics are tested at 95% confidence intervals.

Chapter IV

RESULTS

Intra-examiner repeatability result

The first and the second measurement of white spot lesion were collected in mean gray scale and calculated into LI% both before and after intervention. From Komolgorov-Smirnov statistics, the data had normal distribution and parametric statistics was applied by paired t-test. At 99% confidence level, no significant difference was found between LI% of the first and the second measurement in both before and after intervention, p=0.830 and p=0.823, respectively as in table 6. The results explained that measurement of the same image from examiner was reproducible and intra-examiner repeatability was excellent.

Table 6 Repeatability test of the same image (1st and 2nd measurement) : paired t-test

	1st measurement		2nd measurement		p-value*
	Mean gray scale	LI%	Mean gray scale	LI%	
	$\bar{x} \pm$ SD.		$\bar{x} \pm$ SD.		
Initial	213.862 ± 10.746		213.861 ± 10.749		
Before intervention	226.500 ± 6.820	6.083 ± 4.329	226.498 ± 6.822	6.082 ± 4.329	0.830
After intervention	218.563 ± 6.646	2.361 ± 4.121	218.563 ± 6.647	2.362 ± 4.124	0.823

*P=.01

Experimental result

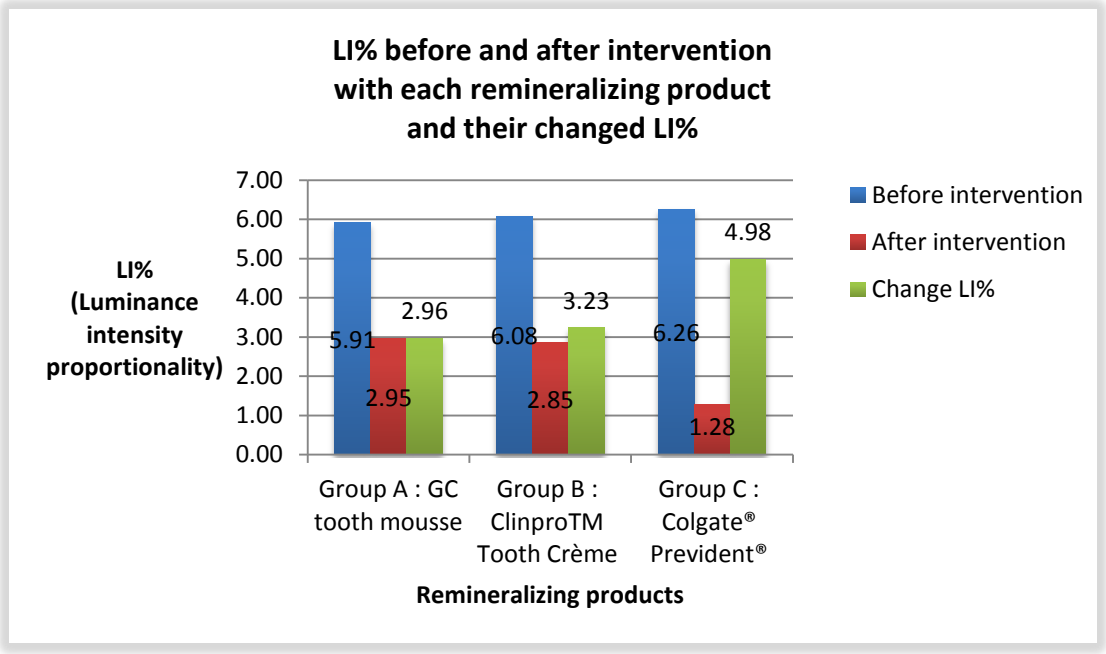
Experimental data of LI% with each remineralizing products and their changed were collected, the table and the chart represented the average value of LI% and changed LI% of three remineralizing products were shown in table 7 and figure 22.

Table 7 LI% before and after intervention with each remineralizing product : paired t-test

Remineralizing product	LI% before intervention ($\bar{x} \pm$ S.D.)	LI% after intervention ($\bar{x} \pm$ S.D.)	Changed LI% ($\bar{x} \pm$ S.D.)	p-value**
Group A	5.91 $\pm$ 4.95	2.95 $\pm$ 4.74	-2.96 $\pm$ 1.73	<0.001**
Group B	6.08 $\pm$ 4.48	2.85 $\pm$ 4.12	-3.23 $\pm$ 1.99	<0.001**
Group C	6.26 $\pm$ 3.59	1.28 $\pm$ 3.29	-4.98 $\pm$ 2.44	<0.001**

**P=.05

Figure 22 LI% before and after intervention with each remineralizing products and their changed LI%



LI% decreased by an average of 2.96 $\pm$ 1.73 for group A, 3.23 $\pm$ 1.99 for group B and 4.98 $\pm$ 2.44 for group C. From Komolgorov-Smirnov statistics, data of LI% of each remineralizing product both before and after intervention had normal distribution and paired t-test was applied to test if there is any difference between LI% before and after intervention of each product. Value of LI% before and after intervention were significantly different for all group ($p<0.001$, table 7).

When first research question was answered relating to the hypotheses, second question is about to find out. Average changed LI% of all remineralizing products were shown in table 7 and analyzed with Komolgorov-Smirnov test. Normal distribution of the data was revealed and one-way-ANOVA was applied. Significant difference was found in comparing group A, group B and group C. After equal variance revealed, Bonferroni statistics was followed for multiple comparison. The result showed that changed LI% of group A/ group C and group B/ group C were significantly different ($p<0.050$) while group A/group B was not significantly different ($p=1.000$) as in table 8.

Table 8 Compare changed LI% between each group : One-way ANOVA and multiple comparison (Bonferroni)

Compare	**Difference ($\bar{x} \pm$ S.D.)**	**p-value****
Group A / Group B	-0.27 $\pm$ 0.54	1.000
Group A / Group C	-2.02 $\pm$ 0.54	0.001**
Group B / Group C	-1.75 + 0.54	0.005**

**P=.05

Chapter V

DISCUSSION AND CONCLUSION

Discussion

Various types of remineralizing products have been studied to find out if they are able to remineralized white spot lesion [6-11] and enamel would be strengthen as well as before the pathology arose. However, patients that seek for orthodontic care expect mostly on esthetic result. After treatment if their teeth are function and well align but white spots are noticeable, it must not be the best result they looked forward to. Numbers of prevention were recommended for white spot lesion after orthodontic treatment. However once they occurred, better solution is to fix them. As mention above that previous studies [9, 11, 29-31, 33, 34] concentrated on mechanical properties without mentioning the optical properties of white spot lesion which affected to patient's smile, in this study, center of attention was moving to the optical appearance of white spot lesion.

Consequently we focused on the luminance intensity change of white spot lesion that was observed by naked eye. Though optical property can be seen, it is hard to detect its change until the combination of photographic technique and computerized image analysis was proposed. [5, 13, 14, 18] Photographic technique was a reproducible procedure of measuring artificial enamel demineralization while several factors were controlled such as light condition, light reflection, slanting of the camera and object's position. [5, 12, 14] Then all images were analyzed with computer.

However, because this method was sensitive, the study was designed as in vitro in order to control more factors and ensure the reproducibility of the measurement. In this experiment, ring flash batteries were replaced strictly according to flash-count limit on the manual [35] , gray card was used as a reference for image calibration and a ruler scale was used to identify the measured positions in the image in order that it could be measured repeatedly. From these additional regimens, this method is reproducible

according to prior studies. [5, 12-15, 18, 24, 26, 27] Moreover repeatability value shown in table1 is even better.

Referring to remineralizing agents, nowadays many products have been released but consumers were familiar to few names and some of them were not over the counter, so that few people is able to get to these products. The chosen three are well known and accessible. In addition, all of them have different active ingredients, perfect for comparative study to generate more information in making their decision.

In previous experiments [7, 10, 11, 31, 33, 34, 36] , intervention cycle contained same frequency and duration for each remineralizing agents application in order to control their environment. But we designed that each product's cycle conformed to its instruction to imitate the consumer's daily use. From different active ingredients, the appropriate application is also different eventually the greatest result assumed to take place when manufacturer's instruction was followed. By this method, the results represented the change of all products when using for a same period of time.

Instead of applying the remineralizing product on each sample one by one which is difficult to avoid error in time counting during the experiment, we designed the container for intervention cycle that all samples can be immersed into the solution at the same time.

From the results, all remineralizing products decreased LI% of artificial white spot lesion significantly. According to Karlinsey et al. [11] , though different variables were measured for remineralization, same results occurred. Active ingredients in each remineralizing products worked in their own way to create remineralization.

- GC tooth mousse decreases optical appearance of white spot lesion from its ability to buffer and increase the level of calcium phosphate in plaque. At the time of calcium phosphate supersaturation, GC is not only inhibiting enamel demineralization but also enhancing enamel remineralization. [6, 8]
- Tri-calcium phosphate mixed with fluoride in Clinpro tooth crème is able to boost up fluoride remineralizing property and avoid compromising fluoride availability. This combination presented greater remineralization in terms of

surface microhardness and enamel fluoride uptake from its capacity of promoting mineral nucleation. [11, 32-34]

- Fluoride creates enamel remineralization by fluoroapatite formation and it has antibacterial effect on cariogenic bacteria. [37, 38]

However, the difference of white spot lesion before and after intervention was obvious when measuring on the surface portion but in deeper part, no difference detected. As shown in Karlinsey et al.'s study [11] that surface microhardness after dentrifrices application was difference while cross sectional microhardness at 50 μm depth or deeper was not difference. It can be assumed that the penetrating ability of remineralizing agents was limited.

Although all groups represented improvement in white spot lesion, group C demonstrated the highest change on white spot lesion, the reason arise from fluoride concentration which group C has 1.1% w/v sodium fluoride or highest fluoride concentration among three groups. With high fluoride concentration, mineral content such as fluoroapatite is about to deposit easier or faster. Even if greatest change occurred, it cannot be inferred that greatest strength took place. Because in this experiment, only optical appearance was measured and alteration of enamel was limited only at the outer surface. Therefore same results were found in Karlinsey et al.'s study [11] that high fluoride concentration resulted in significant increased of enamel's surface microhardness.

Even though this study was designed as in vitro and cannot be referred to the actual clinical results but it was a good initiation to measure white spot lesion as optical change instead of microscopic change. Suggestion for further investigation is to design appropriately for in vivo study or clinical trial.

Conclusion

From the experiment, results have shown that optical appearance of white spot lesion decreased after applied three remineralizing products which presented that all of the remineralizing products chose in this study are able to improve the appearance of

the white spot lesion. Besides, between three products that were compared, Colgate® Prevident® represented the highest change on white spot lesion.

Clinical implications

From the results of this study, it revealed that three types of remineralizing product (GC tooth mousse, Clinpro™ Tooth Crème and Colgate® Prevident® Gel) is capable of improving white spot lesion. Orthodontic patients who suffered from this obvious lesion should consider these products as another treatment option because they are user friendly products and not invasive.

Suggestion

Anyhow, since there was a time limitation for the study, intervention of the product was only 60 cycles imitating product-use for 60 days or 2 months and long term application's result is not exist. Therefore, longer application both in vitro and in vivo may reveal different outcome of each remineralizing product.

Only three remineralizing products were chosen in this experiment, but other type of remineralizing products that contain other active ingredients may show different consequences.

Further investigations could modify numerous factors ; a duration of product's application, other types of remineralizng product, in vivo test or clinical trial, for example. Upon these alterations, new exploration can be broaden out.

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APPENDICES

Appendix A

เอกสารข้อมูลคำอธิบายสำหรับขอฟัน เพื่อใช้ในการทำวิจัย

เรียน .....

ข้าพเจ้า ทพญ. พิมพ์สิริ กันต์พิทยา จะทำการวิจัยเรื่อง การศึกษาเปรียบเทียบผลิตภัณฑ์คืนกลับแร่ธาตุสามชนิด ในการเปลี่ยนแปลงรอยโรคจุดขาวของผิวเคลือบฟันในห้องปฏิบัติการ (Comparative study of three remineralizing products on changing the enamel white spot lesion in vitro.)

ซึ่งเป็นการดำเนินการที่เกี่ยวข้องกับการประเมินความเปลี่ยนแปลงของรอยโรคจุดขาวที่เกิดขึ้น ภายหลังใช้ผลิตภัณฑ์คืนกลับแร่ธาตุ 3 ชนิด และประเมินว่าชนิดใดที่จะทำให้เกิดความเปลี่ยนแปลงของรอยโรคจุดขาวมากที่สุดภายหลังการใช้ผลิตภัณฑ์ ซึ่งจะวัดผลด้วยการถ่ายภาพร่วมกับโปรแกรมการวิเคราะห์ภาพด้วยคอมพิวเตอร์

การศึกษาดังกล่าวเป็นการทดลองที่ทำขึ้นในห้องปฏิบัติการ โดยใช้ฟันแท้ของมนุษย์นำมาสร้างรอยโรคจุดขาวจำลอง จากนั้นทาด้วยผลิตภัณฑ์คืนกลับแร่ธาตุ 3 ชนิด และเปรียบเทียบผลความเปลี่ยนแปลง

ประโยชน์ที่ได้จากการวิจัยครั้งนี้คือ ให้เป็นข้อมูลต่อผู้บริโภค ในการนำไปเลือกใช้ผลิตภัณฑ์ อย่างเหมาะสม

ทั้งนี้ การวิจัยนี้จะต้องใช้ ฟันแท้ (ฟันหน้า, ฟันเขี้ยว, ฟันกรามน้อย, ฟันกราม) จำนวน 90 ซี่ จึงเรียนมาเพื่อขอใช้ ฟันแท้ที่ถูกถอนด้วยเหตุผลเพื่อการรักษา ภายในสถานบริการทางทันตกรรม / คลินิก ซึ่งไม่สามารถที่จะระบุเจ้าของได้และอยู่ในการครอบครองของท่าน

ขอแสดงความนับถือ

.....

(ทพญ. พิมพ์สิริ กันต์พิทยา)

วันที่...../...../.....

Appendix B

Product instruction

- GC tooth mousse
- Clinpro™ Tooth Crème
- Colgate® Prevident® Gel

Each remineralizing product has a brochure for introduction of the product and an instruction manual explaining how to use the product, both frequency and duration and other recommendations for consumer.

All documents are shown as GC tooth mousse, Clinpro™ Tooth Crème and Colgate® Prevident® Gel respectively.

Figure 23 Product instruction : GC tooth mousse 1

Figure 23 Product instruction : GC tooth mousse 1 (continued)

What is GC Tooth Mousse?

A new delicious tasting crème that is beneficial for your teeth.

It contains calcium and phosphate, the major minerals teeth are made from. Because these minerals are carried in a special milk-derived protein called RECALDENT™ (CPP-ACP) they are available in a soluble form. This means GC Tooth Mousse can protect the teeth like saliva and replace minerals lost by regular acid attack after eating and drinking.

GC Tooth Mousse could be helpful

- If you suffer from dry mouth, which could be a side effect of prescription or non prescription medicines
- If you are susceptible to dehydration from sporting activities or outdoor work
- If you currently have orthodontic bands or brackets or have just had them removed
- Immediately following bleaching for tooth whitening
- If you are pregnant and your mouth acid levels are higher than normal
- After your teeth have been cleaned and polished

How to use it

GC Tooth Mousse can be applied into a pre-formed holder called a stent and placed in the mouth. Alternatively squeeze a small amount of GC Tooth Mousse from the tube onto your finger and apply it over the surfaces of the teeth as advised by your dentist. If you are in the middle of orthodontic treatment, apply GC Tooth Mousse around the areas where the bands and brackets are attached to the teeth. Immediately after use replace the cap and clean any excess GC Tooth Mousse from the nozzle of the tube.

How often should I use it?

You should discuss this with your dentist. In most situations you will apply it after brushing your teeth, both morning and night. If starting tooth whitening you will be advised to apply GC Tooth Mousse immediately following each whitening session. When undergoing orthodontic treatment you may be advised to apply GC Tooth Mousse twice daily for the entire time the bands or brackets are attached to your teeth. If you regularly suffer from dry mouth you may need to use GC Tooth Mousse more often. Discuss this with your dentist.

Is GC Tooth Mousse safe to swallow?

Yes. The main ingredient of GC Tooth Mousse is derived from milk casein and like milk and cheese, is edible. GC Tooth Mousse should not be used by people with milk protein allergies or sensitivity to benzoate preservatives.

Do I need to wash it off?

This is a matter of preference. For the maximum benefit, leave it on the teeth as long as possible. The minimum recommended application time is three minutes. You can then rinse the mouth or simply wipe any remaining crème from the teeth.

Does GC Tooth Mousse contain fluoride?

No. However if your dentist recommends that you need an additional fluoride treatment program, you can safely use both GC Tooth Mousse and fluoride products at the same time.

About RECALDENT™ (CPP-ACP)

RECALDENT™ (CPP-ACP) is the result of extensive research over the past 20 years by Professor Eric Reynolds and his research group at The School of Dental Science, The University of Melbourne. The special RECALDENT™ (CPP-ACP) ingredient comes from the milk of the finest Australian and New Zealand cows. It is refined in Australia and then exported overseas for final blending into various manufactured products.

Do you know there is also a RECALDENT™ (CPP-ACP) sugar-free gum?

Recaldent® Gum containing sugar-free xylitol is available in two separate packages either tablets or Recaldent® Kids (Australia and New Zealand only).

Where can I buy these items?

From your dentist.

GC Tooth Mousse should always be used under the supervision of your dentist who will give you individual instructions and advice.

Recaldent

Figure 24 Product instruction : GC tooth mousse 2

Prior to use, carefully read the instructions for use. EN

GC Tooth Mousse

TOPICAL CREME WITH BIO-AVAILABLE CALCIUM AND PHOSPHATE

For use by or under the supervision of a dental professional in the recommended indications.

Description
GC Tooth Mousse is a water based creme containing RECALDENT™* (CPP-ACP: Casein Phosphopeptide - Amorphous Calcium Phosphate). When CPP-ACP is applied in the oral environment, it will bind to biofilms, plaque, bacteria, hydroxyapatite and soft tissue localising bio-available calcium and phosphate.

Important:
Saliva will enhance the effectiveness of CPP-ACP and the flavour will help stimulate saliva flow. The longer CPP-ACP and saliva are maintained in the mouth, the more effective the result.

A topical paste containing bio-available calcium and phosphate
1. Provides extra protection for teeth.
2. Helps neutralize acid challenges from acidogenic bacteria in plaque.
3. Helps neutralize acid challenges from other internal and external acid sources.

CONTRAINDICATIONS
RECALDENT™ (CPP-ACP) is derived from milk casein. Do not use this material on patients with a proven or suspected milk protein allergy and/or with a sensitivity or allergy to benzoate preservatives.

DIRECTIONS FOR USE
INDICATIONS
a. Prior to and following in-office bleaching.
b. After ultrasonic, hand scaling or root planing.
c. Following professional tooth cleaning (P.T.C.).
d. After application of topical fluoride.
e. To provide a topical coating for patients suffering from erosion, xerostomia or Sjögrens syndrome.
f. During orthodontic treatment.
g. For high risk caries patients.
h. For special needs patients.

In-office application:
I. Custom tray application
1. Before use rinse the custom tray thoroughly under running water.
2. Extrude a generous layer of GC Tooth Mousse into the tray and apply to the upper and / or lower teeth.
3. Leave the tray undisturbed in the mouth for a minimum of 3 minutes.
4. Remove the tray.
5. Instruct the patient to use the tongue to spread the remaining GC Tooth Mousse throughout the mouth. Instruct the patient to retain for as long as possible (1- 2 minutes) avoiding expectoration and delaying swallowing. The longer GC Tooth Mousse and saliva are maintained in the mouth, the more effective the result.
6. Ask the patient to expectorate and if possible avoid rinsing. Any GC Tooth Mousse remaining on the surface can be left to gradually dissipate. Advise the patient not to eat or drink for 30 minutes following application.
7. Any residual GC Tooth Mousse in the tray should be rinsed or brushed off under running water immediately after use.

II. Non tray application:
1. If necessary, remove any excess saliva on the tooth surface with a cotton roll or pellet. However, it is NOT necessary to dry the teeth with compressed air.
2. Apply a sufficient amount of GC Tooth Mousse to the tooth surfaces using an application swab, gloved finger or in difficult interproximal areas using an Interproximal Tooth Cleaning Brush.
3. Leave GC Tooth Mousse undisturbed for a minimum of 3 minutes.
4. Then instruct the patient to use the tongue to spread the remaining GC Tooth Mousse throughout the mouth. Request the patient to hold in the mouth for as long as possible (an additional 1 – 2 minutes) avoiding expectoration and delaying swallowing. The longer GC Tooth Mousse and saliva are maintained in the mouth, the more effective the result.
5. Ask the patient to expectorate and if possible avoid rinsing. Any GC Tooth Mousse remaining on the surface can be left to gradually dissipate. Advise the patient not to eat or drink for 30 minutes following application.

Figure 24 Product instruction : GC tooth mousse 2 (continued)

At home application:

III. Day time application after tooth brushing as recommended by a dental professional

1. Apply a sufficient amount of GC Tooth Mousse to upper and lower teeth. A pea size amount for each arch is the minimum required. The material should be applied to the tooth surfaces using a clean dry finger or cotton tip. For difficult areas (between the teeth) use an Interproximal Tooth Cleaning Brush or dental floss coated with GC Tooth Mousse.
2. Leave GC Tooth Mousse on the teeth undisturbed for a minimum of 3 minutes.
3. Then use your tongue to spread the remaining GC Tooth Mousse throughout the mouth. Hold in the mouth for as long as possible (a further 1 – 2 minutes) avoiding expectoration (spitting out) and delaying swallowing. The longer GC Tooth Mousse and saliva are maintained in the mouth, the more effective the result.
4. Expectorate thoroughly and if possible avoid rinsing. Any GC Tooth Mousse remaining on the surface can be left to gradually dissipate. Do not to eat or drink for 30 minutes following application.

IV. Night time application after tooth brushing as recommended by a dental professional

1. Apply a sufficient amount of GC Tooth Mousse to the upper and lower teeth. A pea size amount for each arch is the minimum required. The material should be applied to the tooth surfaces using a clean dry finger or cotton tip. For difficult areas (between the teeth) use an Interproximal Tooth Cleaning Brush or dental floss coated with GC Tooth Mousse.
2. Leave GC Tooth Mousse on the teeth undisturbed for a minimum of 3 minutes.
3. Then use your tongue to spread the remaining GC Tooth Mousse throughout the mouth. Hold in the mouth for as long as possible (a further 1 – 2 minutes) avoiding expectoration (spitting out) and delaying swallowing. The longer GC Tooth Mousse and saliva are maintained in the mouth, the more effective the result.
4. Expectorate thoroughly and if possible avoid rinsing. Any GC Tooth Mousse remaining on the surface can be left to gradually dissipate overnight. Do not eat or drink for 30 minutes following application.

FLAVOURS

Strawberry (S), Melon (M), Vanilla (V), Mint (I), Tutti-Fruit (T)
Note:
S, M, V, I and T in parentheses are abbreviations for each flavour.
These abbreviations are marked on the tubes after lot numbers to show the flavour of the contents.
For example, 021003S.....Strawberry

STORAGE

Store in a cool dry low humidity area away from direct sunlight (8-25°C) (46.4-77.0°F).
(Shelf life: 2 years from date of manufacture)

PACKAGES

Tube containing 40g (35mL)

1. Assorted Package
   10 x 40g (2 each of Strawberry, Melon, Vanilla, Mint, Tutti-Frutti)
2. Single Flavour Package
   10 x 40g in each flavor
   Vanilla, Strawberry, Melon, Tutti-Frutti, Mint
3. Refill Package
   1 x 40g tube in each flavour

NOTE

GC Tooth Mousse with its unique CPP-ACP formulation was developed at The School of Dental Science, The University of Melbourne Victoria Australia.
*RECALDENT is a trademark used under licence. CPP-ACP technology has related patents or patents pending in Australia, NZ, Europe, Canada, and USA.

CAUTION

1. Always replace cap after use and remove any residual paste or moisture around the tube neck or inside the cap.
2. In case of contact with eyes, flush immediately with water and seek medical attention.
3. In case of spillage on clothes, wash off with water.
4. If any angioedema symptoms are experienced, this may indicate sensitivity or allergy to the benzoate preservatives, or to some other component of the product such as a flavouring agent. In this event, discontinue the use of the product and refer to a physician

Last revised : 02/2011

Figure 25 Product instruction : Clinpro™ Tooth Crème

Figure 25 Product instruction : Clinpro™ Tooth Crème (continued)

Figure 26 Product instruction : Colgate® Prevident® Gel

PreviDent® Brush-on gel (1.1% Sodium Fluoride - Rx only)

For patients who should brush twice or use a tray application

Colgate® PreviDent® brush-on gel is a 1.1% neutral sodium fluoride brush-on gel designed for at-home use by all patients who require extra strength fluoride protection. Ideal home therapy for the adult patient.

PRODUCT CHARACTERISTICS

- Arrests 91% of early root caries[1]
- Neutral pH
- Great taste and two different flavors

PRODUCT BENEFITS

- Proven clinically effective
- Safe for crowns and composite restorations
- Patient compliance
- Highest concentration of fluoride available for home use

Figure 26 Product instruction : Colgate® Prevident® Gel (continued)

PRESCRIBING INFORMATION

Description:

Self-topical neutral fluoride gel containing 1.1% sodium fluoride for use as a dental caries preventive in pediatric patients and adults. This prescription product is not a dentifrice.

Ingredients:

Active Ingredient: Sodium fluoride 1.1% (w/v)

Inactive Ingredient: Purified water, sorbitol solution 70%, hydroxyethylcellulose, pluronic F-127, flavor, sodium saccharin, methyl paraben, titanium dioxide, propylparaben, certified dyes (FD&C Red #40 In Bing Cherry and Very Berry flavors, FD&C Blue #1 in Fresh mint flavor)

Clinical Pharmacology:

Frequent topical applications to the teeth with preparations having a relatively high fluoride content increase tooth resistance to acid dissolution and enhance penetration of the fluoride ion into tooth enamel.

Indications and Usage:

A dental caries preventive, for once daily self-applied topical use. It is well established that 1.1% sodium fluoride is safe and extraordinarily effective as a caries preventive when applied frequently with mouthpiece applicators.[1-4] PreviDent® Brush-On Gel in a squeeze-tube is easily applied onto a toothbrush as well as a mouthpiece tray. This prescription dental gel should be used once daily following use of a regular toothpaste unless otherwise instructed by your dental professional. May be used in areas where drinking water is fluoridated since topical fluoride cannot produce fluorosis. (See WARNINGS for exception.)

Contraindications:

Do not use in pediatric patients under age 6 years unless recommended by a dentist or physician.

Warnings:

Prolonged daily ingestion may result in various degrees of dental fluorosis in pediatric patients under age 6 years, especially if the water fluoridation exceeds 0.6 ppm. Use in pediatric patients under age 6 years requires special supervision to prevent repeated swallowing of gel. Read directions carefully before using. Keep out of reach of infants and children.

Precautions:

General: Not for systemic treatment. DO NOT SWALLOW.

Carcinogenesis, Mutagenesis, Impairment of Fertility: In a study conducted in rodents, no carcinogenesis was found in male and female mice and female rats treated with fluoride at dose levels ranging from 4.1 to 9.1 mg/kg of body weight. Equivocal evidence of carcinogenesis was reported in male rats treated with 2.5 and 4.1 mg/kg of body weight. In a second study, no carcinogenesis was observed in rats, males or females, treated with fluoride up to 11.3 mg/kg of body weight. Epidemiological data provide no credible evidence for an association between fluoride, either naturally occurring or added to drinking water, and risk of human cancer.

Fluoride ion is not mutagenic in standard bacterial systems. It has been shown that fluoride ion has potential to induce chromosome aberrations in cultured human and rodent cells at doses much higher than those to which humans are exposed. In vivo data are conflicting. Some studies report chromosome damage in rodents, while other studies using similar protocols report negative results.

Figure 26 Product instruction : Colgate® Prevident® Gel (continued)

Potential adverse reproductive effects of fluoride exposure in humans has not been adequately evaluated. Adverse effects on reproduction were reported for rats, mice, fox, and cattle exposed to 100 ppm or greater concentrations of fluoride in their diet or drinking water. Other studies conducted in rats demonstrated that lower concentrations of fluoride (5 mg/kg of body weight) did not result in impaired fertility and reproductive capabilities.

Pregnancy: It has been shown that fluoride crosses the placenta of rats, but only 0.01% of the amount administered is incorporated in fetal tissue. Animal studies (rats, mice, rabbits) have shown that fluoride is not a teratogen. Maternal exposure to 12.2 mg fluoride/kg of body weight (rats) or 13.1 mg/kg of body weight (rabbits) did not affect the litter size or fetal weight and did not increase the frequency of skeletal or visceral malformations. There are no adequate and well-controlled studies in pregnant women. However, epidemiological studies conducted in areas with high levels of naturally fluoridated water showed no increase in birth defects. Heavy exposure to fluoride during in utero development may result in skeletal fluorosis, which becomes evident in childhood.

Nursing Mothers: It is not known if fluoride is excreted in human milk. However, many drugs are excreted in milk, and caution should be exercised when products containing fluoride are administered to a nursing woman. Reduced milk production was reported in farm-raised fox when the animals were fed a diet containing a high concentration of fluoride (98-137 mg/kg of body weight). No adverse effects on parturition, lactation, or offspring were seen in rats administered fluoride up to 5 mg/kg of body weight.

Pediatric Use: The use of PreviDent Brush-On Gel in pediatric age groups 6 to 16 years as a caries preventive is supported by pioneering clinical studies with 1.1% sodium fluoride gels in mouth trays in students age 11 to 14 years conducted by Englander et al. 2-4 Safety and effectiveness in pediatric patients below the age of 6 years have not been established. Please refer to the CONTRAINDICATIONS and WARNINGS sections.

Figure 26 Product instruction : Colgate® Prevident® Gel (continued)

Adverse Reactions:

Allergic reactions and other idiosyncrasies have been rarely reported.

Overdosage:

Accidental ingestion of large amounts of fluoride may result in acute burning in the mouth and sore tongue. Nausea, vomiting, and diarrhea may occur soon after ingestion (within 30 minutes) and are accompanied by salivation, hematemesis, and epigastric cramping abdominal pain. These symptoms may persist for 24 hours. If less than 5 mg fluoride/kg body weight (i.e., less than 2.3 mg fluoride/lb body weight) have been ingested, give calcium (e.g., milk) orally to relieve gastrointestinal symptoms and observe for a few hours. If more than 5 mg fluoride/kg body weight (i.e., more than 2.3 mg fluoride/lb body weight) have been ingested, induce vomiting, give orally soluble calcium (e.g., milk, 5% calcium gluconate or calcium lactate solution) and immediately seek medical assistance. For accidental ingestion of more than 15 mg fluoride/kg of body weight (i.e., more than 6.9 mg fluoride/lb body weight), induce vomiting and admit immediately to a hospital facility.

A treatment dose (a thin ribbon) of PreviDent® Brush-On Gel contains 2 mg fluoride. A 0.8 oz. tube contains 104 mg fluoride. A 2 oz. tube contains 266 mg fluoride.

Dosage and Administration:

Follow these instructions unless otherwise instructed by your dental professional:

1. After brushing thoroughly with toothpaste, rinse as usual. Adults and pediatric patients 6 years of age or older, apply a thin ribbon of gel to the teeth with a toothbrush or mouth trays once daily for at least one minute, preferably at bedtime.
2. After use, adults expectorate gel. For best results, do not eat, drink or rinse for 30 minutes. Pediatric patients, age 6-16, expectorate gel after use and rinse mouth thoroughly.

How Supplied:

2 oz. (56g) net wt. plastic tubes.

Very Berry: NDC 0126-0288-02
Fresh Mint: NDC 0126-0088-02

Storage:

Store at controlled room temperature, 20-25°C (68-77°F)

Appendix C

Figure 27 Ring flash instruction manual

Canon

MACRO RING LITE MR-14EX

Figure 27 Ring flash instruction manual (continued)

Recycling Time and Flash Count

Battery Type	Recycling Time	Flash Count
Size-AA/LR6 alkaline batteries	Approx. 0.1 - 7 sec.	Approx. 120 - 800

- Based on a new set of batteries and Canon's testing standards.
- The figures are the same for both flash tubes/heads firing or single tube/head firing.
- This applies to both the MR-14EX and MT-24EX.

Use a new set of four batteries of the same brand. When replacing the batteries, replace all four at one time.

- Using size-AA batteries other than the alkaline type (LR6) may cause improper battery contact due to the irregular shape of the battery contacts.
- Size-AA Ni-MH (HR6) or lithium (FR6) batteries can also be used.

To prevent the flash tube/head from deteriorating due to excessive heat, do not fire the flash continuously more than 20 times. After firing the flash continuously for 20 times, let the MR-14EX/MT-24EX rest for 10 min. or longer. During continuous manual flash firing, allow the MR-14EX/MT-24EX to rest after the firing times indicated below.

Flash output	1/1	1/2	1/4	1/8	1/16	1/32	1/64
Firing times	15		20		40		

Appendix D

Intra-examiner repeatability result

Table 9 shows 1st and 2nd measurement of the data.

Experimental result

Table 10 shows data of LI% before intervention, after intervention and their change in changed LI%.

Table 9 Intra-examiner repeatability analysis data

No.	1 st measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
1	182.00	179.00	186.00	185.00	181.00	182.60	210.00	209.00	221.00	218.00	214.00	214.40	17.4151	220.00	219.00	227.00	224.00	221.00	213.84	21.6867
2	181.00	181.00	191.00	191.00	189.00	186.60	206.00	206.00	209.00	212.00	208.00	208.20	11.5756	217.00	214.00	216.00	218.00	217.00	207.60	15.9700
3	203.00	209.00	208.00	205.00	206.00	206.20	228.00	225.00	224.00	223.00	227.00	225.40	9.3113	226.00	225.00	222.00	224.00	224.00	214.80	8.7294
4	199.00	200.00	204.00	205.00	203.00	202.20	226.00	220.00	225.00	230.00	226.00	225.40	11.4738	222.00	219.00	221.00	226.00	221.00	212.88	9.6934
5	202.00	203.00	206.00	201.00	201.00	202.60	219.00	213.00	220.00	216.00	217.00	217.00	7.1076	210.00	208.00	215.00	216.00	212.00	204.24	4.7384
6	181.00	183.00	187.00	185.00	181.00	183.40	226.00	231.00	215.00	219.00	219.00	222.00	21.0469	231.00	228.00	222.00	217.00	219.00	212.64	21.8103
7	206.00	201.00	210.00	212.00	208.00	207.40	227.00	227.00	226.00	225.00	227.00	226.40	9.1610	229.00	229.00	231.00	229.00	229.00	220.32	10.6075
8	201.00	203.00	206.00	203.00	206.00	203.80	216.00	223.00	225.00	220.00	223.00	221.40	8.6359	209.00	213.00	220.00	213.00	212.00	205.92	4.7105
9	198.00	198.00	201.00	201.00	200.00	199.60	227.00	227.00	232.00	229.00	230.00	229.00	14.7295	229.00	227.00	233.00	230.00	230.00	220.80	15.1303
10	208.00	209.00	207.00	211.00	211.00	209.20	222.00	229.00	228.00	227.00	225.00	226.20	8.1262	223.00	227.00	228.00	230.00	231.00	219.84	8.8910
11	201.00	197.00	203.00	206.00	202.00	201.80	210.00	206.00	211.00	210.00	207.00	208.80	3.4688	215.00	206.00	211.00	213.00	211.00	201.84	4.6581
12	204.00	206.00	206.00	205.00	208.00	205.80	227.00	225.00	228.00	228.00	230.00	227.60	10.5928	220.00	221.00	221.00	220.00	214.00	210.24	6.5112
13	202.00	199.00	205.00	204.00	204.00	202.80	221.00	219.00	223.00	223.00	221.00	221.40	9.1716	224.00	227.00	223.00	229.00	228.00	217.68	11.5385
14	206.00	207.00	209.00	208.00	208.00	207.60	226.00	227.00	227.00	228.00	229.00	227.40	9.5376	226.00	228.00	229.00	228.00	227.00	218.88	9.6339
15	197.00	197.00	203.00	204.00	202.00	200.60	215.00	211.00	217.00	214.00	213.00	214.00	6.6800	215.00	212.00	220.00	219.00	218.00	208.56	8.0758

Table 9 Intra-examiner repeatability analysis data (continued)

No.	1 st measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
16	196.00	194.00	198.00	196.00	197.00	196.20	222.00	217.00	222.00	224.00	221.00	221.20	12.7421	215.00	215.00	218.00	218.00	218.00	208.56	10.4995
17	200.00	199.00	201.00	202.00	199.00	200.20	217.00	220.00	216.00	213.00	221.00	217.40	8.5914	212.00	219.00	224.00	218.00	214.00	210.00	8.5914
18	201.00	200.00	204.00	204.00	204.00	202.60	211.00	216.00	221.00	215.00	216.00	215.80	6.5153	215.00	219.00	224.00	218.00	220.00	211.44	8.1935
19	211.00	214.00	217.00	214.00	215.00	214.20	222.00	222.00	228.00	226.00	226.00	224.80	4.9486	227.00	230.00	233.00	230.00	231.00	221.76	7.4697
20	206.00	205.00	203.00	203.00	208.00	205.00	219.00	215.00	214.00	215.00	214.00	215.40	5.0732	211.00	213.00	213.00	216.00	215.00	205.68	4.1951
21	205.00	207.00	202.00	200.00	205.00	203.80	231.00	235.00	237.00	236.00	237.00	235.20	15.4073	234.00	235.00	235.00	232.00	234.00	224.64	14.8184
22	199.00	199.00	208.00	203.00	202.00	202.20	213.00	215.00	219.00	220.00	217.00	216.80	7.2206	219.00	220.00	222.00	223.00	220.00	212.40	9.1988
23	211.00	209.00	214.00	212.00	212.00	211.60	221.00	220.00	221.00	223.00	222.00	221.40	4.6314	217.00	222.00	220.00	220.00	218.00	211.20	3.6862
24	200.00	204.00	206.00	206.00	205.00	204.20	223.00	224.00	222.00	223.00	223.00	223.00	9.2067	227.00	229.00	227.00	226.00	228.00	218.40	11.3614
25	196.00	198.00	203.00	200.00	200.00	199.40	224.00	224.00	224.00	225.00	222.00	223.80	12.2367	214.00	208.00	213.00	213.00	211.00	202.80	6.2187
26	206.00	215.00	212.00	207.00	212.00	210.40	234.00	235.00	234.00	232.00	234.00	233.80	11.1217	239.00	239.00	239.00	239.00	238.00	229.20	13.4981
27	209.00	211.00	210.00	211.00	210.00	210.20	221.00	220.00	222.00	224.00	223.00	222.00	5.6137	225.00	221.00	228.00	227.00	227.00	216.72	7.3264
28	199.00	209.00	209.00	203.00	205.00	205.00	216.00	213.00	217.00	217.00	216.00	215.80	5.2683	220.00	217.00	219.00	222.00	216.00	209.76	6.7317
29	201.00	202.00	199.00	199.00	203.00	200.80	217.00	220.00	217.00	221.00	220.00	219.00	9.0637	219.00	219.00	218.00	216.00	219.00	209.28	8.6653
30	217.00	221.00	221.00	214.00	219.00	218.40	236.00	235.00	234.00	233.00	236.00	234.80	7.5092	227.00	229.00	226.00	227.00	227.00	218.16	4.0293

Table 9 Intra-examiner repeatability analysis data (continued)

No.	1 st measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
31	218.00	218.00	221.00	220.00	222.00	219.80	223.00	222.00	224.00	225.00	226.00	224.00	1.9108	231.00	232.00	234.00	232.00	232.00	223.20	5.6415
32	214.00	215.00	227.00	222.00	217.00	219.00	223.00	221.00	225.00	223.00	225.00	223.40	2.0091	222.00	224.00	226.00	224.00	222.00	215.04	2.1005
33	225.00	223.00	232.00	233.00	229.00	228.40	225.00	223.00	229.00	227.00	221.00	225.00	-1.4886	230.00	230.00	235.00	233.00	232.00	223.20	1.5762
34	218.00	221.00	229.00	226.00	226.00	224.00	216.00	225.00	228.00	221.00	221.00	222.20	-0.8036	219.00	223.00	229.00	225.00	225.00	216.48	0.0893
35	218.00	218.00	223.00	222.00	225.00	221.20	222.00	222.00	226.00	228.00	226.00	224.80	1.6275	225.00	223.00	228.00	230.00	227.00	217.92	2.4412
36	215.00	218.00	227.00	227.00	224.00	222.20	229.00	229.00	233.00	230.00	230.00	230.20	3.6004	221.00	230.00	225.00	224.00	225.00	216.96	1.2601
37	216.00	219.00	226.00	219.00	227.00	221.40	224.00	229.00	231.00	225.00	227.00	227.20	2.6197	221.00	224.00	228.00	224.00	224.00	216.00	1.2647
38	217.00	218.00	223.00	221.00	219.00	219.60	224.00	223.00	226.00	225.00	224.00	224.40	2.1858	232.00	227.00	230.00	230.00	234.00	221.04	5.0091
39	223.00	223.00	228.00	235.00	228.00	227.40	219.00	214.00	222.00	222.00	224.00	220.20	-3.1662	222.00	216.00	219.00	220.00	219.00	209.76	-3.6060
40	220.00	219.00	226.00	226.00	223.00	222.80	226.00	224.00	227.00	230.00	229.00	227.20	1.9749	218.00	217.00	222.00	222.00	221.00	211.68	-1.2567
41	210.00	217.00	225.00	226.00	221.00	219.80	222.00	220.00	227.00	224.00	220.00	222.60	1.2739	228.00	222.00	232.00	232.00	227.00	219.12	3.8217
42	219.00	220.00	221.00	222.00	222.00	220.80	224.00	224.00	222.00	227.00	227.00	224.80	1.8116	229.00	230.00	231.00	232.00	230.00	221.52	4.3478
43	214.00	214.00	229.00	230.00	221.00	221.60	217.00	216.00	232.00	228.00	226.00	223.80	0.9928	230.00	230.00	236.00	231.00	230.00	222.48	4.4224
44	204.00	210.00	212.00	213.00	207.00	209.20	219.00	219.00	223.00	224.00	222.00	221.40	5.8317	224.00	225.00	226.00	227.00	226.00	216.96	7.8394
45	220.00	219.00	223.00	222.00	222.00	221.20	220.00	219.00	222.00	218.00	216.00	219.00	-0.9946	227.00	228.00	232.00	229.00	230.00	220.56	3.6166

Table 9 Intra-examiner repeatability analysis data (continued)

No.	1 st measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
46	255.00	230.00	228.00	251.00	229.00	238.60	236.00	233.00	236.00	236.00	236.00	235.40	-1.3412	234.00	233.00	238.00	237.00	236.00	226.56	-1.2573
47	217.00	218.00	221.00	217.00	218.00	218.20	230.00	231.00	233.00	232.00	233.00	231.80	6.2328	226.00	230.00	231.00	227.00	230.00	220.32	4.8579
48	215.00	210.00	225.00	223.00	217.00	218.00	220.00	216.00	225.00	228.00	222.00	222.20	1.9266	232.00	228.00	234.00	238.00	235.00	224.40	7.0642
49	227.00	228.00	235.00	225.00	229.00	228.80	238.00	236.00	239.00	236.00	239.00	237.60	3.8462	234.00	235.00	238.00	232.00	234.00	225.36	2.5350
50	223.00	218.00	225.00	228.00	229.00	224.60	227.00	225.00	235.00	238.00	233.00	231.60	3.1167	233.00	229.00	234.00	237.00	236.00	224.64	4.0962
51	227.00	230.00	236.00	236.00	239.00	233.60	230.00	231.00	234.00	236.00	235.00	233.20	-0.1712	237.00	235.00	238.00	238.00	236.00	227.28	1.3699
52	203.00	201.00	207.00	217.00	208.00	207.20	226.00	227.00	229.00	230.00	230.00	228.40	10.2317	223.00	219.00	226.00	229.00	226.00	216.00	8.3977
53	212.00	212.00	219.00	220.00	218.00	216.20	232.00	230.00	232.00	235.00	233.00	232.40	7.4931	228.00	227.00	228.00	229.00	228.00	218.88	5.4579
54	215.00	215.00	218.00	212.00	216.00	215.20	220.00	220.00	221.00	218.00	221.00	220.00	2.2305	230.00	230.00	232.00	232.00	230.00	221.76	7.2491
55	221.00	221.00	227.00	225.00	224.00	223.60	233.00	230.00	232.00	233.00	233.00	232.20	3.8462	230.00	231.00	232.00	229.00	233.00	222.00	3.3095
56	216.00	218.00	219.00	222.00	217.00	218.40	222.00	227.00	223.00	224.00	223.00	223.80	2.4725	226.00	228.00	226.00	230.00	229.00	219.12	4.3040
57	197.00	201.00	203.00	202.00	201.00	200.80	215.00	223.00	221.00	216.00	218.00	218.60	8.8645	212.00	212.00	225.00	224.00	219.00	211.20	8.7649
58	217.00	218.00	222.00	224.00	221.00	220.40	231.00	232.00	236.00	234.00	233.00	233.20	5.8076	232.00	233.00	236.00	236.00	234.00	225.36	6.2613
59	210.00	213.00	216.00	217.00	215.00	214.20	220.00	219.00	222.00	222.00	221.00	220.80	3.0812	230.00	231.00	232.00	234.00	233.00	223.20	8.3100
60	207.00	211.00	213.00	211.00	209.00	210.20	229.00	228.00	232.00	231.00	232.00	230.40	9.6099	226.00	228.00	228.00	230.00	227.00	219.12	8.3730

Table 9 Intra-examiner repeatability analysis data (continued)

No.	1 st measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
61	219.00	222.00	226.00	221.00	224.00	222.40	227.00	227.00	226.00	229.00	230.00	227.80	2.4281	225.00	226.00	228.00	231.00	230.00	219.60	2.5180
62	219.00	215.00	218.00	223.00	218.00	218.60	232.00	229.00	230.00	231.00	229.00	230.20	5.3065	237.00	233.00	233.00	233.00	235.00	224.16	7.1363
63	215.00	216.00	219.00	217.00	219.00	217.20	220.00	219.00	221.00	222.00	220.00	220.40	1.4733	222.00	222.00	224.00	224.00	224.00	214.56	2.7624
64	209.00	219.00	215.00	215.00	213.00	214.20	227.00	227.00	230.00	229.00	228.00	228.20	6.5359	227.00	227.00	232.00	230.00	230.00	220.56	7.0028
65	211.00	215.00	220.00	215.00	217.00	215.60	231.00	233.00	235.00	234.00	233.00	233.20	8.1633	232.00	235.00	237.00	237.00	236.00	226.80	9.1837
66	203.00	206.00	211.00	206.00	209.00	207.00	220.00	219.00	225.00	224.00	219.00	221.40	6.9565	218.00	217.00	222.00	221.00	217.00	210.48	5.7971
67	229.00	231.00	235.00	230.00	230.00	231.00	231.00	232.00	231.00	233.00	233.00	232.00	0.4329	234.00	235.00	236.00	235.00	235.00	225.84	1.7316
68	218.00	218.00	221.00	222.00	222.00	220.20	233.00	233.00	239.00	235.00	235.00	235.00	6.7212	220.00	221.00	224.00	231.00	226.00	216.48	1.9074
69	217.00	220.00	229.00	224.00	223.00	222.60	228.00	230.00	234.00	232.00	231.00	231.00	3.7736	232.00	239.00	232.00	233.00	237.00	225.84	5.3908
70	225.00	227.00	232.00	223.00	226.00	226.60	228.00	233.00	228.00	227.00	230.00	229.20	1.1474	232.00	234.00	233.00	230.00	231.00	222.72	2.3831
71	209.00	216.00	221.00	218.00	218.00	216.40	227.00	229.00	233.00	233.00	231.00	230.60	6.5619	232.00	232.00	235.00	232.00	233.00	223.68	7.5786
72	214.00	217.00	231.00	227.00	224.00	222.60	224.00	236.00	236.00	237.00	238.00	234.20	5.2111	232.00	236.00	237.00	235.00	235.00	226.32	5.5705
73	225.00	227.00	233.00	229.00	228.00	228.40	231.00	233.00	234.00	233.00	234.00	233.00	2.0140	233.00	232.00	234.00	235.00	235.00	224.64	2.3643
74	207.00	211.00	219.00	217.00	215.00	213.80	227.00	230.00	233.00	232.00	231.00	230.60	7.8578	224.00	225.00	231.00	229.00	228.00	219.12	6.3611
75	218.00	218.00	224.00	224.00	221.00	221.00	229.00	230.00	235.00	235.00	234.00	232.60	5.2489	235.00	235.00	238.00	239.00	239.00	228.24	7.3303

Table 9 Intra-examiner repeatability analysis data (continued)

No.	1 st measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
76	207.00	216.00	216.00	209.00	213.00	212.20	236.00	236.00	237.00	235.00	235.00	235.80	11.1216	230.00	231.00	231.00	230.00	230.00	221.28	8.5768
77	215.00	217.00	226.00	223.00	220.00	220.20	226.00	226.00	230.00	230.00	229.00	228.20	3.6331	229.00	227.00	228.00	229.00	226.00	218.40	3.4514
78	215.00	213.00	215.00	214.00	214.00	214.20	232.00	227.00	224.00	229.00	218.00	226.00	5.5089	219.00	222.00	223.00	222.00	227.00	214.56	3.9216
79	203.00	208.00	217.00	211.00	213.00	210.40	232.00	236.00	234.00	236.00	235.00	234.60	11.5019	236.00	239.00	235.00	236.00	236.00	227.04	12.3574
80	212.00	218.00	219.00	216.00	216.00	216.20	232.00	235.00	236.00	238.00	232.00	234.60	8.5106	234.00	238.00	241.00	239.00	239.00	229.68	10.1758
81	218.00	223.00	228.00	224.00	226.00	223.80	226.00	231.00	237.00	236.00	233.00	232.60	3.9321	231.00	233.00	237.00	234.00	234.00	225.12	4.4683
82	218.00	223.00	220.00	218.00	218.00	219.40	231.00	231.00	230.00	231.00	231.00	230.80	5.1960	232.00	233.00	235.00	235.00	233.00	224.64	6.4722
83	210.00	214.00	217.00	215.00	215.00	214.20	233.00	234.00	234.00	234.00	233.00	233.60	9.0570	226.00	225.00	228.00	225.00	229.00	217.68	5.7890
84	209.00	211.00	214.00	214.00	211.00	211.80	233.00	228.00	236.00	239.00	234.00	234.00	10.4816	230.00	227.00	226.00	231.00	225.00	218.16	7.5543
85	223.00	224.00	224.00	226.00	225.00	224.40	238.00	239.00	241.00	241.00	241.00	240.00	6.9519	239.00	238.00	241.00	240.00	240.00	230.16	6.7736
86	211.00	213.00	213.00	213.00	213.00	212.60	230.00	230.00	233.00	231.00	230.00	230.80	8.5607	231.00	230.00	231.00	230.00	230.00	221.04	8.3725
87	212.00	214.00	219.00	215.00	215.00	215.00	230.00	230.00	233.00	234.00	231.00	231.60	7.7209	236.00	237.00	239.00	239.00	238.00	228.72	10.6047
88	230.00	232.00	233.00	235.00	231.00	232.20	239.00	239.00	241.00	243.00	240.00	240.40	3.5314	232.00	236.00	239.00	238.00	234.00	227.28	1.5504
89	226.00	227.00	228.00	228.00	227.00	227.20	234.00	234.00	236.00	236.00	235.00	235.00	3.4331	234.00	227.00	237.00	233.00	236.00	223.92	2.7289
90	199.00	203.00	206.00	205.00	204.00	203.40	221.00	214.00	225.00	223.00	222.00	221.00	8.6529	223.00	224.00	228.00	225.00	226.00	216.72	10.7178

Table 9 Intra-examiner repeatability analysis data (continued)

No.	2 nd measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
1	182.00	179.00	185.00	185.00	181.00	182.40	210.00	209.00	221.00	218.00	214.00	214.40	17.5439	220.00	219.00	227.00	224.00	221.00	222.20	21.8202
2	181.00	181.00	191.00	191.00	189.00	186.60	206.00	206.00	209.00	212.00	208.00	208.20	11.5756	217.00	214.00	216.00	218.00	217.00	216.40	15.9700
3	203.00	209.00	208.00	205.00	206.00	206.20	228.00	225.00	224.00	223.00	227.00	225.40	9.3113	226.00	225.00	222.00	224.00	224.00	224.20	8.7294
4	199.00	200.00	204.00	205.00	203.00	202.20	226.00	220.00	225.00	230.00	226.00	225.40	11.4738	222.00	219.00	221.00	226.00	221.00	221.80	9.6934
5	202.00	203.00	206.00	201.00	201.00	202.60	219.00	213.00	220.00	216.00	217.00	217.00	7.1076	210.00	208.00	215.00	216.00	212.00	212.20	4.7384
6	181.00	183.00	187.00	185.00	181.00	183.40	226.00	231.00	215.00	219.00	219.00	222.00	21.0469	231.00	228.00	222.00	217.00	219.00	223.40	21.8103
7	206.00	201.00	210.00	212.00	208.00	207.40	227.00	227.00	226.00	225.00	227.00	226.40	9.1610	229.00	229.00	231.00	229.00	229.00	229.40	10.6075
8	201.00	203.00	206.00	203.00	206.00	203.80	216.00	223.00	225.00	220.00	223.00	221.40	8.6359	209.00	213.00	220.00	213.00	212.00	213.40	4.7105
9	198.00	198.00	201.00	201.00	200.00	199.60	227.00	227.00	232.00	229.00	230.00	229.00	14.7295	229.00	227.00	233.00	230.00	230.00	229.80	15.1303
10	208.00	209.00	207.00	211.00	211.00	209.20	222.00	229.00	228.00	227.00	225.00	226.20	8.1262	223.00	227.00	228.00	230.00	231.00	227.80	8.8910
11	201.00	197.00	203.00	206.00	202.00	201.80	210.00	206.00	211.00	210.00	207.00	208.80	3.4688	215.00	206.00	211.00	213.00	211.00	211.20	4.6581
12	204.00	206.00	206.00	205.00	208.00	205.80	227.00	225.00	228.00	228.00	230.00	227.60	10.5928	220.00	221.00	221.00	220.00	214.00	219.20	6.5112
13	202.00	199.00	205.00	204.00	204.00	202.80	221.00	219.00	223.00	223.00	221.00	221.40	9.1716	224.00	227.00	223.00	229.00	228.00	226.20	11.5385
14	206.00	207.00	209.00	208.00	208.00	207.60	226.00	227.00	227.00	228.00	229.00	227.40	9.5376	226.00	227.00	229.00	228.00	227.00	227.40	9.5376
15	197.00	197.00	203.00	204.00	202.00	200.60	215.00	211.00	217.00	214.00	213.00	214.00	6.6800	215.00	212.00	220.00	219.00	218.00	216.80	8.0758

Table 9 Intra-examiner repeatability analysis data (continued)

No.	2 nd measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
16	196.00	194.00	198.00	196.00	197.00	196.20	222.00	217.00	222.00	224.00	221.00	221.20	12.7421	215.00	215.00	218.00	218.00	218.00	216.80	10.4995
17	200.00	199.00	201.00	202.00	199.00	200.20	217.00	220.00	216.00	213.00	221.00	217.40	8.5914	212.00	219.00	224.00	218.00	214.00	217.40	8.5914
18	201.00	200.00	204.00	204.00	204.00	202.60	211.00	216.00	221.00	215.00	216.00	215.80	6.5153	215.00	219.00	224.00	218.00	220.00	219.20	8.1935
19	211.00	214.00	217.00	214.00	215.00	214.20	222.00	222.00	228.00	226.00	226.00	224.80	4.9486	227.00	230.00	233.00	230.00	231.00	230.20	7.4697
20	206.00	205.00	203.00	203.00	208.00	205.00	219.00	215.00	214.00	215.00	214.00	215.40	5.0732	211.00	213.00	213.00	216.00	215.00	213.60	4.1951
21	205.00	207.00	202.00	200.00	205.00	203.80	231.00	235.00	237.00	236.00	237.00	235.20	15.4073	234.00	235.00	235.00	232.00	234.00	234.00	14.8184
22	199.00	199.00	208.00	203.00	202.00	202.20	213.00	215.00	219.00	220.00	217.00	216.80	7.2206	219.00	220.00	222.00	223.00	220.00	220.80	9.1988
23	211.00	209.00	214.00	212.00	212.00	211.60	221.00	220.00	221.00	223.00	222.00	221.40	4.6314	217.00	222.00	220.00	220.00	218.00	219.40	3.6862
24	200.00	204.00	206.00	206.00	205.00	204.20	223.00	224.00	222.00	223.00	223.00	223.00	9.2067	227.00	229.00	227.00	226.00	228.00	227.40	11.3614
25	196.00	198.00	203.00	200.00	200.00	199.40	224.00	224.00	224.00	225.00	222.00	223.80	12.2367	214.00	208.00	213.00	213.00	211.00	211.80	6.2187
26	206.00	215.00	212.00	207.00	212.00	210.40	234.00	235.00	234.00	232.00	234.00	233.80	11.1217	239.00	239.00	239.00	239.00	238.00	238.80	13.4981
27	209.00	211.00	210.00	211.00	210.00	210.20	221.00	220.00	222.00	224.00	223.00	222.00	5.6137	225.00	221.00	228.00	227.00	227.00	225.60	7.3264
28	199.00	209.00	209.00	203.00	205.00	205.00	216.00	213.00	217.00	217.00	216.00	215.80	5.2683	220.00	217.00	219.00	222.00	216.00	218.80	6.7317
29	201.00	202.00	199.00	199.00	203.00	200.80	217.00	220.00	217.00	221.00	220.00	219.00	9.0637	219.00	219.00	218.00	216.00	219.00	218.20	8.6653
30	217.00	221.00	221.00	214.00	219.00	218.40	236.00	235.00	234.00	233.00	236.00	234.80	7.5092	227.00	229.00	226.00	227.00	227.00	227.20	4.0293

Table 9 Intra-examiner repeatability analysis data (continued)

No.	2 nd measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
31	218.00	218.00	221.00	220.00	222.00	219.80	223.00	222.00	224.00	225.00	226.00	224.00	1.9108	231.00	232.00	234.00	232.00	232.00	232.20	5.6415
32	214.00	215.00	227.00	222.00	217.00	219.00	223.00	221.00	225.00	223.00	225.00	223.40	2.0091	222.00	224.00	226.00	224.00	222.00	223.60	2.1005
33	225.00	223.00	232.00	233.00	229.00	228.40	225.00	223.00	229.00	227.00	221.00	225.00	-1.4886	230.00	230.00	235.00	233.00	232.00	232.00	1.5762
34	218.00	221.00	229.00	226.00	226.00	224.00	216.00	225.00	228.00	221.00	221.00	222.20	-0.8036	219.00	223.00	229.00	225.00	225.00	224.20	0.0893
35	218.00	218.00	223.00	222.00	225.00	221.20	222.00	222.00	226.00	228.00	226.00	224.80	1.6275	225.00	223.00	228.00	230.00	227.00	226.60	2.4412
36	215.00	218.00	227.00	227.00	224.00	222.20	229.00	229.00	233.00	230.00	230.00	230.20	3.6004	221.00	230.00	225.00	224.00	225.00	225.00	1.2601
37	216.00	219.00	226.00	219.00	227.00	221.40	224.00	229.00	231.00	225.00	227.00	227.20	2.6197	221.00	224.00	228.00	224.00	224.00	224.20	1.2647
38	217.00	218.00	223.00	221.00	219.00	219.60	224.00	223.00	226.00	225.00	224.00	224.40	2.1858	232.00	227.00	230.00	230.00	234.00	230.60	5.0091
39	223.00	223.00	228.00	235.00	228.00	227.40	219.00	214.00	222.00	222.00	224.00	220.20	-3.1662	222.00	216.00	219.00	220.00	219.00	219.20	-3.6060
40	220.00	219.00	226.00	226.00	223.00	222.80	226.00	224.00	227.00	230.00	229.00	227.20	1.9749	218.00	217.00	222.00	222.00	221.00	220.00	-1.2567
41	210.00	217.00	225.00	226.00	221.00	219.80	222.00	220.00	227.00	224.00	220.00	222.60	1.2739	228.00	222.00	232.00	232.00	227.00	228.20	3.8217
42	219.00	220.00	221.00	222.00	222.00	220.80	224.00	224.00	222.00	227.00	227.00	224.80	1.8116	229.00	230.00	231.00	232.00	230.00	230.40	4.3478
43	214.00	214.00	229.00	230.00	221.00	221.60	217.00	216.00	232.00	228.00	226.00	223.80	0.9928	230.00	230.00	236.00	231.00	230.00	231.40	4.4224
44	204.00	210.00	212.00	213.00	207.00	209.20	219.00	219.00	223.00	224.00	222.00	221.40	5.8317	224.00	225.00	226.00	227.00	226.00	225.60	7.8394
45	220.00	219.00	223.00	222.00	222.00	221.20	220.00	219.00	222.00	218.00	216.00	219.00	-0.9946	227.00	228.00	232.00	229.00	230.00	229.20	3.6166

Table 9 Intra-examiner repeatability analysis data (continued)

No.	2 nd measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
46	255.00	230.00	228.00	251.00	229.00	238.60	236.00	233.00	236.00	236.00	236.00	235.40	-1.3412	234.00	233.00	238.00	237.00	236.00	235.60	-1.2573
47	217.00	218.00	221.00	217.00	218.00	218.20	230.00	231.00	233.00	232.00	233.00	231.80	6.2328	226.00	230.00	231.00	227.00	230.00	228.80	4.8579
48	215.00	210.00	225.00	223.00	217.00	218.00	220.00	216.00	225.00	228.00	222.00	222.20	1.9266	232.00	228.00	234.00	238.00	235.00	233.40	7.0642
49	227.00	228.00	235.00	225.00	229.00	228.80	238.00	236.00	239.00	236.00	239.00	237.60	3.8462	234.00	235.00	238.00	232.00	234.00	234.60	2.5350
50	223.00	218.00	225.00	228.00	229.00	224.60	227.00	225.00	235.00	238.00	233.00	231.60	3.1167	233.00	229.00	234.00	237.00	236.00	233.80	4.0962
51	227.00	230.00	236.00	236.00	239.00	233.60	230.00	231.00	234.00	236.00	235.00	233.20	-0.1712	237.00	235.00	238.00	238.00	236.00	236.80	1.3699
52	203.00	201.00	207.00	217.00	208.00	207.20	226.00	227.00	229.00	230.00	230.00	228.40	10.2317	223.00	219.00	226.00	229.00	226.00	224.60	8.3977
53	212.00	212.00	219.00	220.00	218.00	216.20	232.00	230.00	232.00	235.00	233.00	232.40	7.4931	228.00	227.00	228.00	229.00	228.00	228.00	5.4579
54	215.00	215.00	218.00	212.00	216.00	215.20	220.00	220.00	221.00	218.00	221.00	220.00	2.2305	230.00	230.00	232.00	232.00	230.00	230.80	7.2491
55	221.00	221.00	227.00	225.00	224.00	223.60	233.00	230.00	232.00	233.00	233.00	232.20	3.8462	230.00	231.00	232.00	229.00	233.00	231.00	3.3095
56	216.00	218.00	219.00	222.00	217.00	218.40	222.00	227.00	223.00	224.00	223.00	223.80	2.4725	226.00	228.00	226.00	230.00	229.00	227.80	4.3040
57	197.00	201.00	203.00	202.00	201.00	200.80	215.00	223.00	221.00	216.00	218.00	218.60	8.8645	212.00	212.00	225.00	224.00	219.00	218.40	8.7649
58	217.00	218.00	222.00	224.00	221.00	220.40	231.00	232.00	236.00	234.00	233.00	233.20	5.8076	232.00	233.00	236.00	236.00	234.00	234.20	6.2613
59	210.00	213.00	216.00	217.00	215.00	214.20	220.00	219.00	222.00	222.00	221.00	220.80	3.0812	230.00	231.00	232.00	234.00	233.00	232.00	8.3100
60	207.00	211.00	213.00	211.00	209.00	210.20	229.00	228.00	232.00	231.00	232.00	230.40	9.6099	226.00	228.00	228.00	230.00	227.00	227.80	8.3730

Table 9 Intra-examiner repeatability analysis data (continued)

No.	2 nd measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
61	219.00	222.00	226.00	221.00	224.00	222.40	227.00	227.00	226.00	229.00	230.00	227.80	2.4281	225.00	226.00	228.00	231.00	230.00	228.00	2.5180
62	219.00	215.00	218.00	223.00	218.00	218.60	232.00	229.00	230.00	231.00	229.00	230.20	5.3065	237.00	233.00	233.00	233.00	235.00	234.20	7.1363
63	215.00	216.00	219.00	217.00	219.00	217.20	220.00	219.00	221.00	222.00	220.00	220.40	1.4733	222.00	222.00	224.00	224.00	224.00	223.20	2.7624
64	209.00	219.00	215.00	215.00	213.00	214.20	227.00	227.00	230.00	229.00	228.00	228.20	6.5359	227.00	227.00	232.00	230.00	230.00	229.20	7.0028
65	211.00	215.00	220.00	215.00	217.00	215.60	231.00	233.00	235.00	234.00	233.00	233.20	8.1633	232.00	235.00	237.00	237.00	236.00	235.40	9.1837
66	203.00	206.00	211.00	206.00	209.00	207.00	220.00	219.00	225.00	224.00	219.00	221.40	6.9565	218.00	217.00	222.00	221.00	217.00	219.00	5.7971
67	229.00	231.00	235.00	230.00	230.00	231.00	231.00	232.00	231.00	233.00	233.00	232.00	0.4329	234.00	235.00	236.00	235.00	235.00	235.00	1.7316
68	218.00	218.00	221.00	222.00	222.00	220.20	233.00	233.00	239.00	235.00	235.00	235.00	6.7212	220.00	221.00	224.00	231.00	226.00	224.40	1.9074
69	217.00	220.00	229.00	224.00	223.00	222.60	228.00	230.00	234.00	232.00	231.00	231.00	3.7736	232.00	239.00	232.00	233.00	237.00	234.60	5.3908
70	225.00	227.00	232.00	223.00	226.00	226.60	228.00	233.00	228.00	227.00	230.00	229.20	1.1474	232.00	234.00	233.00	230.00	231.00	232.00	2.3831
71	209.00	216.00	221.00	218.00	218.00	216.40	227.00	229.00	233.00	233.00	231.00	230.60	6.5619	232.00	232.00	235.00	232.00	233.00	232.80	7.5786
72	214.00	217.00	231.00	227.00	224.00	222.60	224.00	236.00	236.00	237.00	238.00	234.20	5.2111	232.00	236.00	237.00	235.00	235.00	235.00	5.5705
73	225.00	227.00	233.00	229.00	228.00	228.40	231.00	233.00	234.00	233.00	234.00	233.00	2.0140	233.00	232.00	234.00	235.00	235.00	233.80	2.3643
74	207.00	211.00	219.00	217.00	215.00	213.80	227.00	230.00	233.00	232.00	231.00	230.60	7.8578	224.00	225.00	231.00	229.00	228.00	227.40	6.3611
75	218.00	218.00	224.00	224.00	221.00	221.00	229.00	230.00	235.00	235.00	234.00	232.60	5.2489	235.00	235.00	238.00	239.00	239.00	237.20	7.3303

Table 9 Intra-examiner repeatability analysis data (continued)

No.	2 nd measurement																		
	Initial						Before intervention							After intervention					
	Mean gray scale (0-256)					Avg.	Mean gray scale (0-256)					Avg.	LI%	Mean gray scale (0-256)					Avg.	LI%
	1 st	2 nd	3 rd	4 th	5 th		1 st	2 nd	3 rd	4 th	5 th			1 st	2 nd	3 rd	4 th	5 th		
76	207.00	216.00	216.00	209.00	213.00	212.20	236.00	236.00	236.00	235.00	235.00	235.60	11.0273	230.00	231.00	231.00	230.00	230.00	230.40	8.5768
77	215.00	217.00	226.00	223.00	220.00	220.20	226.00	226.00	230.00	230.00	229.00	228.20	3.6331	229.00	227.00	228.00	229.00	226.00	227.80	3.4514
78	215.00	213.00	215.00	214.00	214.00	214.20	232.00	227.00	224.00	229.00	218.00	226.00	5.5089	219.00	222.00	223.00	222.00	227.00	222.60	3.9216
79	203.00	208.00	217.00	211.00	213.00	210.40	232.00	236.00	234.00	236.00	235.00	234.60	11.5019	236.00	239.00	235.00	236.00	236.00	236.40	12.3574
80	212.00	218.00	219.00	216.00	216.00	216.20	232.00	235.00	236.00	238.00	232.00	234.60	8.5106	234.00	238.00	241.00	239.00	239.00	238.20	10.1758
81	218.00	223.00	228.00	224.00	226.00	223.80	226.00	231.00	237.00	236.00	233.00	232.60	3.9321	231.00	233.00	237.00	234.00	234.00	233.80	4.4683
82	218.00	223.00	220.00	218.00	218.00	219.40	231.00	231.00	230.00	231.00	231.00	230.80	5.1960	232.00	233.00	235.00	235.00	233.00	233.60	6.4722
83	210.00	214.00	217.00	215.00	215.00	214.20	233.00	234.00	234.00	234.00	233.00	233.60	9.0570	226.00	225.00	228.00	225.00	229.00	226.60	5.7890
84	209.00	211.00	214.00	214.00	211.00	211.80	233.00	228.00	236.00	239.00	234.00	234.00	10.4816	230.00	227.00	226.00	231.00	225.00	227.80	7.5543
85	223.00	224.00	224.00	226.00	225.00	224.40	238.00	239.00	241.00	241.00	241.00	240.00	6.9519	239.00	238.00	241.00	240.00	240.00	239.60	6.7736
86	211.00	213.00	213.00	213.00	213.00	212.60	230.00	230.00	233.00	231.00	230.00	230.80	8.5607	231.00	230.00	231.00	230.00	230.00	230.40	8.3725
87	212.00	214.00	219.00	215.00	215.00	215.00	230.00	230.00	233.00	234.00	231.00	231.60	7.7209	236.00	237.00	239.00	239.00	238.00	237.80	10.6047
88	230.00	232.00	233.00	235.00	231.00	232.20	239.00	239.00	241.00	243.00	240.00	240.40	3.5314	232.00	236.00	239.00	238.00	234.00	235.80	1.5504
89	226.00	227.00	228.00	228.00	227.00	227.20	234.00	234.00	236.00	236.00	235.00	235.00	3.4331	234.00	227.00	237.00	233.00	236.00	233.40	2.7289
90	199.00	203.00	206.00	205.00	204.00	203.40	221.00	214.00	225.00	223.00	222.00	221.00	8.6529	223.00	224.00	228.00	225.00	226.00	225.20	10.7178

Table 10 Experimental data

No.	Group	Tooth	Initial (Sound enamel)						Before intervention							After intervention							Changed LI%
			Mean gray scale (ranged 0-256)					Avg.	Mean gray scale (ranged 0-256)					Avg.	LI%	Mean gray scale (ranged 0-256)					Avg.	LI%	
			1st	2nd	3rd	4th	5th		1st	2nd	3rd	4th	5th			1st	2nd	3rd	4th	5th			
1	A	Canine	182.00	179.00	186.00	185.00	181.00	182.60	210.00	209.00	221.00	218.00	214.00	214.40	17.42	220.00	219.00	227.00	224.00	221.00	213.84	17.11	0.31
2	B	Canine	181.00	181.00	191.00	191.00	189.00	186.60	206.00	206.00	209.00	212.00	208.00	208.20	11.58	217.00	214.00	216.00	218.00	217.00	207.60	11.25	0.32
3	C	Canine	203.00	209.00	208.00	205.00	206.00	206.20	228.00	225.00	224.00	223.00	227.00	225.40	9.31	226.00	225.00	222.00	224.00	224.00	214.80	4.17	5.14
4	A	Canine	199.00	200.00	204.00	205.00	203.00	202.20	226.00	220.00	225.00	230.00	226.00	225.40	11.47	222.00	219.00	221.00	226.00	221.00	212.88	5.28	6.19
5	C	Canine	202.00	203.00	206.00	201.00	201.00	202.60	219.00	213.00	220.00	216.00	217.00	217.00	7.11	210.00	208.00	215.00	216.00	212.00	204.24	0.81	6.30
6	B	Canine	181.00	183.00	187.00	185.00	181.00	183.40	226.00	231.00	215.00	219.00	219.00	222.00	21.05	231.00	228.00	222.00	217.00	219.00	212.64	15.94	5.10
7	B	Ant.	206.00	201.00	210.00	212.00	208.00	207.40	227.00	227.00	226.00	225.00	227.00	226.40	9.16	229.00	229.00	231.00	229.00	229.00	220.32	6.23	2.93
8	C	Ant.	201.00	203.00	206.00	203.00	206.00	203.80	216.00	223.00	225.00	220.00	223.00	221.40	8.64	209.00	213.00	220.00	213.00	212.00	205.92	1.04	7.60
9	A	Ant.	198.00	198.00	201.00	201.00	200.00	199.60	227.00	227.00	232.00	229.00	230.00	229.00	14.73	229.00	227.00	233.00	230.00	230.00	220.80	10.62	4.11
10	B	Ant.	208.00	209.00	207.00	211.00	211.00	209.20	222.00	229.00	228.00	227.00	225.00	226.20	8.13	223.00	227.00	228.00	230.00	231.00	219.84	5.09	3.04
11	A	Ant.	201.00	197.00	203.00	206.00	202.00	201.80	210.00	206.00	211.00	210.00	207.00	208.80	3.47	215.00	206.00	211.00	213.00	211.00	201.84	0.02	3.45
12	C	Ant.	204.00	206.00	206.00	205.00	208.00	205.80	227.00	225.00	228.00	228.00	230.00	227.60	10.59	220.00	221.00	221.00	220.00	214.00	210.24	2.16	8.44
13	C	Ant.	202.00	199.00	205.00	204.00	204.00	202.80	221.00	219.00	223.00	223.00	221.00	221.40	9.17	224.00	227.00	223.00	229.00	228.00	217.68	7.34	1.83
14	B	Ant.	206.00	207.00	209.00	208.00	208.00	207.60	226.00	227.00	227.00	228.00	229.00	227.40	9.54	226.00	228.00	229.00	228.00	227.00	218.88	5.43	4.10
15	A	Ant.	197.00	197.00	203.00	204.00	202.00	200.60	215.00	211.00	217.00	214.00	213.00	214.00	6.68	215.00	212.00	220.00	219.00	218.00	208.56	3.97	2.71

Table 10 Experimental data (continued)

No.	Group	Tooth	Initial (Sound enamel)						Before intervention							After intervention							Changed LI%
			Mean gray scale (ranged 0-256)					Avg.	Mean gray scale (ranged 0-256)					Avg.	LI%	Mean gray scale (ranged 0-256)					Avg.	LI%	
			1st	2nd	3rd	4th	5th		1st	2nd	3rd	4th	5th			1st	2nd	3rd	4th	5th			
16	C	Ant.	196.00	194.00	198.00	196.00	197.00	196.20	222.00	217.00	222.00	224.00	221.00	221.20	12.74	215.00	215.00	218.00	218.00	218.00	208.56	6.30	6.44
17	A	Ant.	200.00	199.00	201.00	202.00	199.00	200.20	217.00	220.00	216.00	213.00	221.00	217.40	8.59	212.00	219.00	224.00	218.00	214.00	210.00	4.90	3.70
18	B	Ant.	201.00	200.00	204.00	204.00	204.00	202.60	211.00	216.00	221.00	215.00	216.00	215.80	6.52	215.00	219.00	224.00	218.00	220.00	211.44	4.36	2.15
19	C	Ant.	211.00	214.00	217.00	214.00	215.00	214.20	222.00	222.00	228.00	226.00	226.00	224.80	4.95	227.00	230.00	233.00	230.00	231.00	221.76	3.53	1.42
20	B	Ant.	206.00	205.00	203.00	203.00	208.00	205.00	219.00	215.00	214.00	215.00	214.00	215.40	5.07	211.00	213.00	213.00	216.00	215.00	205.68	0.33	4.74
21	A	Ant.	205.00	207.00	202.00	200.00	205.00	203.80	231.00	235.00	237.00	236.00	237.00	235.20	15.41	234.00	235.00	235.00	232.00	234.00	224.64	10.23	5.18
22	A	Ant.	199.00	199.00	208.00	203.00	202.00	202.20	213.00	215.00	219.00	220.00	217.00	216.80	7.22	219.00	220.00	222.00	223.00	220.00	212.40	5.04	2.18
23	C	Ant.	211.00	209.00	214.00	212.00	212.00	211.60	221.00	220.00	221.00	223.00	222.00	221.40	4.63	217.00	222.00	220.00	220.00	218.00	211.20	-0.19	4.82
24	B	Ant.	200.00	204.00	206.00	206.00	205.00	204.20	223.00	224.00	222.00	223.00	223.00	223.00	9.21	227.00	229.00	227.00	226.00	228.00	218.40	6.95	2.25
25	C	Ant.	196.00	198.00	203.00	200.00	200.00	199.40	224.00	224.00	224.00	225.00	222.00	223.80	12.24	214.00	208.00	213.00	213.00	211.00	202.80	1.71	10.53
26	A	Ant.	206.00	215.00	212.00	207.00	212.00	210.40	234.00	235.00	234.00	232.00	234.00	233.80	11.12	239.00	239.00	239.00	239.00	238.00	229.20	8.94	2.19
27	B	Ant.	209.00	211.00	210.00	211.00	210.00	210.20	221.00	220.00	222.00	224.00	223.00	222.00	5.61	225.00	221.00	228.00	227.00	227.00	216.72	3.10	2.51
28	B	Ant.	199.00	209.00	209.00	203.00	205.00	205.00	216.00	213.00	217.00	217.00	216.00	215.80	5.27	220.00	217.00	219.00	222.00	216.00	209.76	2.32	2.95
29	A	Ant.	201.00	202.00	199.00	199.00	203.00	200.80	217.00	220.00	217.00	221.00	220.00	219.00	9.06	219.00	219.00	218.00	216.00	219.00	209.28	4.22	4.84
30	C	Ant.	217.00	221.00	221.00	214.00	219.00	218.40	236.00	235.00	234.00	233.00	236.00	234.80	7.51	227.00	229.00	226.00	227.00	227.00	218.16	-0.11	7.62

Table 10 Experimental data (continued)

No.	Group	Tooth	Initial (Sound enamel)						Before intervention							After intervention							Changed LI%
			Mean gray scale (ranged 0-256)					Avg.	Mean gray scale (ranged 0-256)					Avg.	LI%	Mean gray scale (ranged 0-256)					Avg.	LI%	
			1st	2nd	3rd	4th	5th		1st	2nd	3rd	4th	5th			1st	2nd	3rd	4th	5th			
31	B	Molar	218.00	218.00	221.00	220.00	222.00	219.80	223.00	222.00	224.00	225.00	226.00	224.00	1.91	231.00	232.00	234.00	232.00	232.00	223.20	1.55	0.36
32	C	Molar	214.00	215.00	227.00	222.00	217.00	219.00	223.00	221.00	225.00	223.00	225.00	223.40	2.01	222.00	224.00	226.00	224.00	222.00	215.04	-1.81	3.82
33	A	Molar	225.00	223.00	232.00	233.00	229.00	228.40	225.00	223.00	229.00	227.00	221.00	225.00	-1.49	230.00	230.00	235.00	233.00	232.00	223.20	-2.28	0.79
34	A	Molar	218.00	221.00	229.00	226.00	226.00	224.00	216.00	225.00	228.00	221.00	221.00	222.20	-0.80	219.00	223.00	229.00	225.00	225.00	216.48	-3.36	2.55
35	B	Molar	218.00	218.00	223.00	222.00	225.00	221.20	222.00	222.00	226.00	228.00	226.00	224.80	1.63	225.00	223.00	228.00	230.00	227.00	217.92	-1.48	3.11
36	C	Molar	215.00	218.00	227.00	227.00	224.00	222.20	229.00	229.00	233.00	230.00	230.00	230.20	3.60	221.00	230.00	225.00	224.00	225.00	216.96	-2.36	5.96
37	B	Molar	216.00	219.00	226.00	219.00	227.00	221.40	224.00	229.00	231.00	225.00	227.00	227.20	2.62	221.00	224.00	228.00	224.00	224.00	216.00	-2.44	5.06
38	A	Molar	217.00	218.00	223.00	221.00	219.00	219.60	224.00	223.00	226.00	225.00	224.00	224.40	2.19	232.00	227.00	230.00	230.00	234.00	221.04	0.66	1.53
39	C	Molar	223.00	223.00	228.00	235.00	228.00	227.40	219.00	214.00	222.00	222.00	224.00	220.20	-3.17	222.00	216.00	219.00	220.00	219.00	209.76	-7.76	4.59
40	C	Molar	220.00	219.00	226.00	226.00	223.00	222.80	226.00	224.00	227.00	230.00	229.00	227.20	1.97	218.00	217.00	222.00	222.00	221.00	211.68	-4.99	6.97
41	B	Molar	210.00	217.00	225.00	226.00	221.00	219.80	222.00	220.00	227.00	224.00	220.00	222.60	1.27	228.00	222.00	232.00	232.00	227.00	219.12	-0.31	1.58
42	A	Molar	219.00	220.00	221.00	222.00	222.00	220.80	224.00	224.00	222.00	227.00	227.00	224.80	1.81	229.00	230.00	231.00	232.00	230.00	221.52	0.33	1.49
43	A	Molar	214.00	214.00	229.00	230.00	221.00	221.60	217.00	216.00	232.00	228.00	226.00	223.80	0.99	230.00	230.00	236.00	231.00	230.00	222.48	0.40	0.60
44	C	Molar	204.00	210.00	212.00	213.00	207.00	209.20	219.00	219.00	223.00	224.00	222.00	221.40	5.83	224.00	225.00	226.00	227.00	226.00	216.96	3.71	2.12
45	B	Molar	220.00	219.00	223.00	222.00	222.00	221.20	220.00	219.00	222.00	218.00	216.00	219.00	-0.99	227.00	228.00	232.00	229.00	230.00	220.56	-0.29	-0.71

Table 10 Experimental data (continued)

No.	Group	Tooth	Initial (Sound enamel)						Before intervention							After intervention							Changed LI%
			Mean gray scale (ranged 0-256)					Avg.	Mean gray scale (ranged 0-256)					Avg.	LI%	Mean gray scale (ranged 0-256)					Avg.	LI%	
			1st	2nd	3rd	4th	5th		1st	2nd	3rd	4th	5th			1st	2nd	3rd	4th	5th			
46	A	Premolar	255.00	230.00	228.00	251.00	229.00	238.60	236.00	233.00	236.00	236.00	236.00	235.40	-1.34	234.00	233.00	238.00	237.00	236.00	226.56	-5.05	3.70
47	B	Premolar	217.00	218.00	221.00	217.00	218.00	218.20	230.00	231.00	233.00	232.00	233.00	231.80	6.23	226.00	230.00	231.00	227.00	230.00	220.32	0.97	5.26
48	C	Premolar	215.00	210.00	225.00	223.00	217.00	218.00	220.00	216.00	225.00	228.00	222.00	222.20	1.93	232.00	228.00	234.00	238.00	235.00	224.40	2.94	-1.01
49	B	Premolar	227.00	228.00	235.00	225.00	229.00	228.80	238.00	236.00	239.00	236.00	239.00	237.60	3.85	234.00	235.00	238.00	232.00	234.00	225.36	-1.50	5.35
50	C	Premolar	223.00	218.00	225.00	228.00	229.00	224.60	227.00	225.00	235.00	238.00	233.00	231.60	3.12	233.00	229.00	234.00	237.00	236.00	224.64	0.02	3.10
51	A	Premolar	227.00	230.00	236.00	236.00	239.00	233.60	230.00	231.00	234.00	236.00	235.00	233.20	-0.17	237.00	235.00	238.00	238.00	236.00	227.28	-2.71	2.53
52	C	Premolar	203.00	201.00	207.00	217.00	208.00	207.20	226.00	227.00	229.00	230.00	230.00	228.40	10.23	223.00	219.00	226.00	229.00	226.00	216.00	4.25	5.98
53	A	Premolar	212.00	212.00	219.00	220.00	218.00	216.20	232.00	230.00	232.00	235.00	233.00	232.40	7.49	228.00	227.00	228.00	229.00	228.00	218.88	1.24	6.25
54	B	Premolar	215.00	215.00	218.00	212.00	216.00	215.20	220.00	220.00	221.00	218.00	221.00	220.00	2.23	230.00	230.00	232.00	232.00	230.00	221.76	3.05	-0.82
55	C	Premolar	221.00	221.00	227.00	225.00	224.00	223.60	233.00	230.00	232.00	233.00	233.00	232.20	3.85	230.00	231.00	232.00	229.00	233.00	222.00	-0.72	4.56
56	B	Premolar	216.00	218.00	219.00	222.00	217.00	218.40	222.00	227.00	223.00	224.00	223.00	223.80	2.47	226.00	228.00	226.00	230.00	229.00	219.12	0.33	2.14
57	A	Premolar	197.00	201.00	203.00	202.00	201.00	200.80	215.00	223.00	221.00	216.00	218.00	218.60	8.86	212.00	212.00	225.00	224.00	219.00	211.20	5.18	3.69
58	B	Premolar	217.00	218.00	222.00	224.00	221.00	220.40	231.00	232.00	236.00	234.00	233.00	233.20	5.81	232.00	233.00	236.00	236.00	234.00	225.36	2.25	3.56
59	A	Premolar	210.00	213.00	216.00	217.00	215.00	214.20	220.00	219.00	222.00	222.00	221.00	220.80	3.08	230.00	231.00	232.00	234.00	233.00	223.20	4.20	-1.12
60	C	Premolar	207.00	211.00	213.00	211.00	209.00	210.20	229.00	228.00	232.00	231.00	232.00	230.40	9.61	226.00	228.00	228.00	230.00	227.00	219.12	4.24	5.37

Table 10 Experimental data (continued)

No.	Group	Tooth	Initial (Sound enamel)						Before intervention							After intervention							Changed LI%
			Mean gray scale (ranged 0-256)					Avg.	Mean gray scale (ranged 0-256)					Avg.	LI%	Mean gray scale (ranged 0-256)					Avg.	LI%	
			1st	2nd	3rd	4th	5th		1st	2nd	3rd	4th	5th			1st	2nd	3rd	4th	5th			
61	C	Premolar	219.00	222.00	226.00	221.00	224.00	222.40	227.00	227.00	226.00	229.00	230.00	227.80	2.43	225.00	226.00	228.00	231.00	230.00	219.60	-1.26	3.69
62	A	Premolar	219.00	215.00	218.00	223.00	218.00	218.60	232.00	229.00	230.00	231.00	229.00	230.20	5.31	237.00	233.00	233.00	233.00	235.00	224.16	2.54	2.76
63	B	Premolar	215.00	216.00	219.00	217.00	219.00	217.20	220.00	219.00	221.00	222.00	220.00	220.40	1.47	222.00	222.00	224.00	224.00	224.00	214.56	-1.22	2.69
64	A	Premolar	209.00	219.00	215.00	215.00	213.00	214.20	227.00	227.00	230.00	229.00	228.00	228.20	6.54	227.00	227.00	232.00	230.00	230.00	220.56	2.97	3.57
65	B	Premolar	211.00	215.00	220.00	215.00	217.00	215.60	231.00	233.00	235.00	234.00	233.00	233.20	8.16	232.00	235.00	237.00	237.00	236.00	226.80	5.19	2.97
66	C	Premolar	203.00	206.00	211.00	206.00	209.00	207.00	220.00	219.00	225.00	224.00	219.00	221.40	6.96	218.00	217.00	222.00	221.00	217.00	210.48	1.68	5.28
67	B	Premolar	229.00	231.00	235.00	230.00	230.00	231.00	231.00	232.00	231.00	233.00	233.00	232.00	0.43	234.00	235.00	236.00	235.00	235.00	225.84	-2.23	2.67
68	C	Premolar	218.00	218.00	221.00	222.00	222.00	220.20	233.00	233.00	239.00	235.00	235.00	235.00	6.72	220.00	221.00	224.00	231.00	226.00	216.48	-1.69	8.41
69	A	Premolar	217.00	220.00	229.00	224.00	223.00	222.60	228.00	230.00	234.00	232.00	231.00	231.00	3.77	232.00	239.00	232.00	233.00	237.00	225.84	1.46	2.32
70	A	Premolar	225.00	227.00	232.00	223.00	226.00	226.60	228.00	233.00	228.00	227.00	230.00	229.20	1.15	232.00	234.00	233.00	230.00	231.00	222.72	-1.71	2.86
71	C	Premolar	209.00	216.00	221.00	218.00	218.00	216.40	227.00	229.00	233.00	233.00	231.00	230.60	6.56	232.00	232.00	235.00	232.00	233.00	223.68	3.36	3.20
72	B	Premolar	214.00	217.00	231.00	227.00	224.00	222.60	224.00	236.00	236.00	237.00	238.00	234.20	5.21	232.00	236.00	237.00	235.00	235.00	226.32	1.67	3.54
73	A	Premolar	225.00	227.00	233.00	229.00	228.00	228.40	231.00	233.00	234.00	233.00	234.00	233.00	2.01	233.00	232.00	234.00	235.00	235.00	224.64	-1.65	3.66
74	A	Premolar	207.00	211.00	219.00	217.00	215.00	213.80	227.00	230.00	233.00	232.00	231.00	230.60	7.86	224.00	225.00	231.00	229.00	228.00	219.12	2.49	5.37
75	B	Premolar	218.00	218.00	224.00	224.00	221.00	221.00	229.00	230.00	235.00	235.00	234.00	232.60	5.25	235.00	235.00	238.00	239.00	239.00	228.24	3.28	1.97

Table 10 Experimental data (continued)

No.	Group	Tooth	Initial (Sound enamel)						Before intervention							After intervention							Changed LI%
			Mean gray scale (ranged 0-256)					Avg.	Mean gray scale (ranged 0-256)					Avg.	LI%	Mean gray scale (ranged 0-256)					Avg.	LI%	
			1st	2nd	3rd	4th	5th		1st	2nd	3rd	4th	5th			1st	2nd	3rd	4th	5th			
76	B	Premolar	207.00	216.00	216.00	209.00	213.00	212.20	236.00	236.00	237.00	235.00	235.00	235.80	11.12	230.00	231.00	231.00	230.00	230.00	221.28	4.28	6.84
77	C	Premolar	215.00	217.00	226.00	223.00	220.00	220.20	226.00	226.00	230.00	230.00	229.00	228.20	3.63	229.00	227.00	228.00	229.00	226.00	218.40	-0.82	4.45
78	C	Premolar	215.00	213.00	215.00	214.00	214.00	214.20	232.00	227.00	224.00	229.00	218.00	226.00	5.51	219.00	222.00	223.00	222.00	227.00	214.56	0.17	5.34
79	B	Premolar	203.00	208.00	217.00	211.00	213.00	210.40	232.00	236.00	234.00	236.00	235.00	234.60	11.50	236.00	239.00	235.00	236.00	236.00	227.04	7.91	3.59
80	A	Premolar	212.00	218.00	219.00	216.00	216.00	216.20	232.00	235.00	236.00	238.00	232.00	234.60	8.51	234.00	238.00	241.00	239.00	239.00	229.68	6.23	2.28
81	C	Premolar	218.00	223.00	228.00	224.00	226.00	223.80	226.00	231.00	237.00	236.00	233.00	232.60	3.93	231.00	233.00	237.00	234.00	234.00	225.12	0.59	3.34
82	A	Premolar	218.00	223.00	220.00	218.00	218.00	219.40	231.00	231.00	230.00	231.00	231.00	230.80	5.20	232.00	233.00	235.00	235.00	233.00	224.64	2.39	2.81
83	B	Premolar	210.00	214.00	217.00	215.00	215.00	214.20	233.00	234.00	234.00	234.00	233.00	233.60	9.06	226.00	225.00	228.00	225.00	229.00	217.68	1.62	7.43
84	C	Premolar	209.00	211.00	214.00	214.00	211.00	211.80	233.00	228.00	236.00	239.00	234.00	234.00	10.48	230.00	227.00	226.00	231.00	225.00	218.16	3.00	7.48
85	C	Premolar	223.00	224.00	224.00	226.00	225.00	224.40	238.00	239.00	241.00	241.00	241.00	240.00	6.95	239.00	238.00	241.00	240.00	240.00	230.16	2.57	4.39
86	B	Premolar	211.00	213.00	213.00	213.00	213.00	212.60	230.00	230.00	233.00	231.00	230.00	230.80	8.56	231.00	230.00	231.00	230.00	230.00	221.04	3.97	4.59
87	A	Premolar	212.00	214.00	219.00	215.00	215.00	215.00	230.00	230.00	233.00	234.00	231.00	231.60	7.72	236.00	237.00	239.00	239.00	238.00	228.72	6.38	1.34
88	B	Premolar	230.00	232.00	233.00	235.00	231.00	232.20	239.00	239.00	241.00	243.00	240.00	240.40	3.53	232.00	236.00	239.00	238.00	234.00	227.28	-2.12	5.65
89	A	Premolar	226.00	227.00	228.00	228.00	227.00	227.20	234.00	234.00	236.00	236.00	235.00	235.00	3.43	234.00	227.00	237.00	233.00	236.00	223.92	-1.44	4.88
90	C	Premolar	199.00	203.00	206.00	205.00	204.00	203.40	221.00	214.00	225.00	223.00	222.00	221.00	8.65	223.00	224.00	228.00	225.00	226.00	216.72	6.55	2.10

Appendix E

SPSS Statistic tables

Intra-examiner repeatability test

1. Before intervention

1.1 LI% (normal distribution test)

One-Sample Kolmogorov-Smirnov Test

		1st measurement	2nd measurement
N		90	90
Normal Parameters[a,,b]	Mean	6.0827	6.0831
	Std. Deviation	4.32911	4.33170
Most Extreme Differences	Absolute	.068	.068
	Positive	.068	.068
	Negative	-.042	-.042
Kolmogorov-Smirnov Z		.646	.645
Asymp. Sig. (2-tailed)		.798	.799

a. Test distribution is Normal.

b. Calculated from data.

1.2 Paired t-test (repeatability test : 1st VS 2nd measurement)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	1st measurement	6.0827	90	4.32911	.45633
	2nd measurement	6.0831	90	4.33170	.45660

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	1st measurement & 2nd measurement	90	1.000	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	99% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	1st measurement – 2nd measurement	-.00038	.01692	.00178	-.00508	.00431	-.215	89	.830

2. After intervention

2.1 LI% (normal distribution test)

One-Sample Kolmogorov-Smirnov Test

		1st measurement	2nd Measurement
N		90	90
Normal Parameters[a,,b]	Mean	6.4785	6.4789
	Std. Deviation	4.33687	4.34138
Most Extreme Differences	Absolute	.089	.089
	Positive	.089	.089
	Negative	-.070	-.070
Kolmogorov-Smirnov Z		.844	.847
Asymp. Sig. (2-tailed)		.474	.471

a. Test distribution is Normal.

b. Calculated from data.

2.2 Paired t-test (repeatability test : 1st VS 2nd measurement)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	1st measurement	6.4785	90	4.33687	.45715
	2nd measurement	6.4789	90	4.34138	.45762

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	1st measurement & 2nd measurement	90	1.000	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	99% Confidence Interval of the Difference Lower	Upper			
Pair 1	1st measurement – 2nd measurement	-.00041	.01744	.00184	-.00525	.00443	-.225	89	.823

Experimental test

1. LI% : before VS after intervention

1.1 GC tooth mousse

1.1.1 LI% (normal distribution test)

One-Sample Kolmogorov-Smirnov Test

Product			Before intervention	After intervention
GC tooth mousse	N		30	30
	Normal Parameters[a,,b]	Mean	9.4400	5.2697
		Std. Deviation	3.97165	4.38629
	Most Extreme Differences	Absolute	.157	.152
		Positive	.157	.152
		Negative	-.080	-.107
	Kolmogorov-Smirnov Z		.858	.833
	Asymp. Sig. (2-tailed)		.453	.491

a. Test distribution is Normal.

b. Calculated from data.

1.1.2 Paired t-test (before VS after intervention)

Paired Samples Statistics

Product			Mean	N	Std. Deviation	Std. Error Mean
GC tooth mousse	Pair 1	Before	9.4400	30	3.97165	.72512
		After	5.2697	30	4.38629	.80082

Paired Samples Correlations

Product			N	Correlation	Sig.
GC tooth mousse	Pair 1	Before & After	30	.838	.000

Paired Samples Test

			Paired Differences					t	df	Sig. (2-tailed)
						95% Confidence Interval of the Difference				
Product			Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
GC tooth mousse	Pair 1	Before - After	4.17033	2.40913	.43985	3.27075	5.06992	9.481	29	.000

1.2 Clinpro™ Tooth Crème

1.2.1 LI% (normal distribution test)

One-Sample Kolmogorov-Smirnov Test

Product			Before intervention	After intervention
Clinpro™ tooth creme	N		30	30
	Normal Parameters[a,,b]	Mean	2.8877	-.0580
		Std. Deviation	3.28055	3.09209
	Most Extreme Differences	Absolute	.151	.068
		Positive	.151	.048
		Negative	-.084	-.068
	Kolmogorov-Smirnov Z		.829	.370
	Asymp. Sig. (2-tailed)		.498	.999

a. Test distribution is Normal.

b. Calculated from data.

1.2.2 Paired t-test (before VS after intervention)

Paired Samples Statistics

Product		Mean	N	Std. Deviation	Std. Error Mean
Clinpro™ tooth creme	Pair 1 Before	2.8877	30	3.28055	.59894
	After	-.0580	30	3.09209	.56454

Paired Samples Correlations

Product		N	Correlation	Sig.
Clinpro™ tooth creme	Pair 1 Before & After	30	.732	.000

Paired Samples Test

			Paired Differences					t	df	Sig. (2-tailed)
						95% Confidence Interval of the Difference				
Product			Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Clinpro tooth creme	Pair 1	Before - After	2.94567	2.33903	.42705	2.07226	3.81908	6.898	29	.000

1.3 Colgate® Prevident® Gel

1.3.1 LI% (normal distribution test)

One-Sample Kolmogorov-Smirnov Test

Product			Before intervention	After intervention
Prevident	N		30	30
	Normal Parameters[a,,b]	Mean	5.9203	1.8720
		Std. Deviation	2.95642	2.87825
	Most Extreme Differences	Absolute	.083	.125
		Positive	.083	.125
		Negative	-.083	-.077
	Kolmogorov-Smirnov Z		.455	.686
	Asymp. Sig. (2-tailed)		.986	.734

a. Test distribution is Normal.

b. Calculated from data.

1.3.2 Paired t-test (before VS after intervention)

Paired Samples Statistics

Product			Mean	N	Std. Deviation	Std. Error Mean
Prevident	Pair 1	Before	5.9203	30	2.95642	.53977
		After	1.8720	30	2.87825	.52549

Paired Samples Correlations

Product			N	Correlation	Sig.
Prevident	Pair 1	Before & After	30	.814	.000

Paired Samples Test

			Paired Differences					t	df	Sig. (2-tailed)
						95% Confidence Interval of the Difference				
Product			Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Prevident	Pair 1	Before - After	4.04833	1.78255	.32545	3.38272	4.71395	12.439	29	.000

2. Changed LI% between 3 groups of intervention

2.1 LI% (normal distribution test)

One-Sample Kolmogorov-Smirnov Test

		ChangedLI
N		90
Normal Parameters[a,,b]	Mean	3.7213
	Std. Deviation	2.23983
Most Extreme Differences	Absolute	.081
	Positive	.081
	Negative	-.057
Kolmogorov-Smirnov Z		.766
Asymp. Sig. (2-tailed)		.601

a. Test distribution is Normal.

b. Calculated from data.

2.2 One-way ANOVA

ANOVA

Changed LI%

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	71.928	2	35.964	8.353	.000
Within Groups	374.569	87	4.305		
Total	446.498	89			

Multiple Comparisons

Changed LI%

Bonferroni

(I) product	(J) product	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
GC tooth mousse	Clinpro™ tooth creme	-.27532	.53575	1.000	-1.5832	1.0325
	Prevident	-2.01903*	.53575	.001	-3.3269	-.7112
Clinpro™ tooth creme	GC tooth mousse	.27532	.53575	1.000	-1.0325	1.5832
	Prevident	-1.74371*	.53575	.005	-3.0516	-.4359
Prevident	GC tooth mousse	2.01903*	.53575	.001	.7112	3.3269
	Clinpro™ tooth creme	1.74371*	.53575	.005	.4359	3.0516

*. The mean difference is significant at the 0.05 level.

Biography

Miss Pimsiri Kanpittaya was born on 15th October 1985. She graduated her Doctor of Dental Surgery from Chulalongkorn University in 2008. After graduation, she worked at Hua-Hin hospital as a general practitioner for 1 year. In 2010, she started her Master degree at Chulalongkorn University in Orthodontic department and continued ever since.