THE USE OF RENEW^{TM} DENTIFRICE IN THE PREVENTION OF WHITE SPOT LESIONS ASSOCIATED WITH ORTHODONTIC TREATMENT

By

ANDREW E. CLARK

A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2012

To my daughter Leighton

ACKNOWLEDGMENTS

I would like to thank Tim Wheeler, Sue McGorray, Cal Dolce, and Ingvar Magnussen for all their help and guidance along the way. Also I would like to give a big thank you to Brenda Thacker for all her help throughout the entire research process. Additionally I would like to thank my wife, Langley. Finally I would like to thank my father, Dr. Arthur Clark, for his guidance and help throughout dental school and my orthodontic residency.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CRT	Caries Risk Test
DI	Decalcification Index
GI	Gingival Index
Max	Maximum
Min	Minimum
N	Number of subjects
Oz	Ounce
PI	Plaque index
PPM	Parts per million
S. MUTANS	*Streptococcus Mutans*
Std Dev	Standard deviation
WSLS	White Spot Lesions

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

THE USE OF RENEW™ DENTIFRICE IN THE PREVENTION OF WHITE SPOT LESIONS ASSOCIATED WITH ORTHODONTIC TREATMENT

By

Andrew E. Clark

December 2012

Chair: Calogero Dolce
Major: Dental Sciences- Orthodontics

Once orthodontic treatment commences there is an increase in plaque as compared to normal conditions. This increase in plaque can lead to increased acid production and demineralization of the teeth. All studies reviewed showed an increase in WSLs with orthodontic treatment. Due to the difficulty in detection the best way to manage these lesions is through prevention. Renew™ is a dentifrice that contains 5% by weight novamin (calcium sodium phosphosilicate bioactive glass) and 5000 ppm fluoride has been examined for a possible adjunct to help with prevention of the WSLs.

25 subjects were followed for six months during orthodontic treatment and randomly assigned to two different groups blinded from both subject and examiner. One group received the ReNew™ dentifrice while the other group received an over the counter dentifrice of similar color and texture. During the six months the subjects were seen monthly. At three and six month appointments a plaque index, gingival index, decalcification index and bacterial test were performed. Results were compared from both the control and treatment groups to determine if ReNew™ will lead to a decrease in the WSLs associated with orthodontic treatment.

Out of the 25 patients that initiated the study 20 completed the entire 6 months. A fisher exact test showed that between control and experimental groups there was no difference in age, gender or race. Based on a two sample t-test there was no statistically significant difference in PI, GI and DI between control and experimental group. However for both groups there was a statistically significant increase in GI and PI from baseline to 6 months but not in DI. No difference between Renew^{TM} dentifrice and Crest dentifrice in prevention of WSLs formation.

CHAPTER 1
INTRODUCTION

Enamel demineralization is a common problem in orthodontics, which affects a majority of patients undergoing orthodontic treatment. Both brackets and bands may contribute to an increase in plaque that is observed in patients that are treated with orthodontics.[1] This demineralization appears as a lesion called a White Spot Lesion (WSL or WSLs).

WSLs are caused by a buildup of plaque around the brackets or bands that leads to an increase in the cariogenic bacteria, Streptococcus mutans and Lactobaccilus, portion of the plaque.[2] The cariogenic bacteria metabolizes sucrose to form an acidic challenge to the teeth which leads to the observed demineralization. Demineralization is defined as a loss of calcium from the hydroxyl-apatite crystals, which leaves the tooth more vulnerable to further bacterial attack.[1] The WSLs seen in orthodontics are exacerbated by poor oral hygiene and frequent intake of cariogenic food.[2] These lesions can form in only four weeks and are often characterized with black edges.[2] The maxillary lateral and mandibular canines are the most common teeth implicated, with the distal gingival area of the labial enamel being the most common site of the lesions.[2]

The prevalence of reported WSLs varies widely in the numerous studies conducted on this subject, however, the majority of the studies agree that once orthodontics are involved, there will be an increase in the number of these lesions. A study by Ogaard investigated patients that were post-orthodontic treatment for an average of five years.[3] This study found that of the patients who had undergone orthodontic treatment, only 4% of the patients did not display any lesions, while 15% of

the control group displayed no lesions.[3] This study also showed that the orthodontic group had a statistically significant higher median number of these lesions with a higher proportion of teeth being affected. A second study by Lovrov characterized the amount of WSLs and subsequent demineralization by categorizing patients into predetermined levels based on the size and number of lesions.[4] This study found that only 3 of the 33 patients did not increase at least one level in severity. Another study found that 33.8% of the 101 patients studied developed at least 1 WSL after treatment.[5] In 1982, Gorelick et al. compared a control group of patients to patients with bonded teeth, bracketed teeth, and teeth with mandibular lingual retainers.[6] The control group had only 3.6% of 1006 teeth with a slight white spot formation. This compares to the bonded teeth where 10.8% of the 2211 teeth had WSLs and the bracketed teeth (maxillary incisors) where 12% of 280 teeth developed WSLs.

Diagnosis of these lesions is most often done by direct visualization, which is problematic because the demineralization has already substantially occurred on the teeth. As technology has improved there have been a number of new systems tested to help detect demineralization, including polarized light microscopy, transverse microscopy, QLF, visualization, electron microscopy and stereomicroscopy.[7] However the majority of the studies using these methods were done *in vitro* and do not translate well to clinical use.

Because of the difficulty in detecting WSLs, the most important method of dealing with these lesions is prevention. Dentistry, in general, is undergoing a change in the approaches used when treating dental caries. As opposed to treating only once carious lesions develop, patients are categorized into risk levels, and based on these levels the

number and strength of preventative measures are determined. The previous data discussed also supports this concept change, in that WSLs should not only be dealt with once they start to develop, but patients should be placed in preventive categories based on oral hygiene, caries risk and potentially S. *mutans* levels in the oral cavity. The best way to prevent the WSLs is through excellent oral hygiene, because if plaque is not harbored around the brackets then the acid attack will not develop.[1] Further, Geiger et al. found that despite oral hygiene instructions with consistent reinforcement at subsequent appointments, the compliance rate was only rated excellent for 15% of the patients.[5] Based on this conclusion patients at higher risk levels may need additional mechanisms to prevent the WSLs.

Traditionally different fluoride regimes and types of application have been studied to determine the best approach to prevent these WSLs. A new product called ReNew™, which contains 5% by weight novamin (calcium sodium phosphosilicate bioactive glass) and 5000 ppm fluoride has been examined for a possible adjunct to help with prevention of the WSLs. Novamin responds to an aqueous environment by releasing sodium ions which exchange with hydrogen cations, which leads to calcium and phosphate being released from the bioglass.[8] This causes an increase in the pH of the mouth which encourages the precipitation of calcium and phosphate from both saliva and novamin to form a calcium-phosphate complex.[8] This complex crystallizes in hydroxycarbonate apatite, which is chemically and structurally similar to biological apatite.[9] Two possible mechanisms of this product in preventing WSLs are seen. First, the increase in pH to counter the acid challenge produced by the bacteria and second, the production and incorporation of the apatite formed that is similar to the biological apatite of teeth.

Several studies done *in vitro* and *in situ* have examined the effect of the Novamin product on extracted teeth. One study examined the microhardness of dentin and enamel in both the prevention and restoration of demineralization. All four parts found an increased microhardness of both dentin and enamel when compared to controls and fluoride alone.[8] Only one study by Diamanti et al., found a decreased hardness with the novamin product when compared to high fluoride concentration toothpaste.[10] However this study tested only the effects on dentin with no use on enamel. The findings of these studies warrant a need for examining this product which contains both novamin and fluoride *in vivo* to determine if it is more appropriate than fluoride toothpaste alone to prevent these WSLs.

CHAPTER 2
METHODS

Study Design: The study was a prospective, double blind, randomized clinical trial taking place at a single clinical site. IRB approval was obtained and subjects were recruited from the resident orthodontic clinic at the University of Florida. 25 subjects between the ages of 11-24 were recruited consisting of 19 males and 6 females, determined to have moderate to poor oral hygiene, at least 6 months of orthodontic treatment remaining, benign medical history, under current care of general dentist and healthy periodontium. All females were required to take a pregnancy test with a negative result prior to acceptance into the study. Five subjects were dismissed early from study due to missed appointments, failure to meet inclusion criteria, early removal of orthodontic appliances and orthodontic prescription of MI paste. Once informed consent was obtained, a preliminary examination was done including a review of medical history, gingival index and detection of WSLs present. The subjects were then given a dental cleaning and oral hygiene instructions by either a certified dental hygienist or orthodontic resident. The subjects were then randomly divided into two groups and received one of two pre-weighed dentifrices (1.4 oz), blinded from both the subject and the examiner. The subject was then seen monthly for 6 months for an intraoral exam, additional toothbrushes and dentifrice, supervised brushing and continuation of orthodontic treatment. At the 3 and 6 months the examiner performed a new gingival index, decalcification index, plaque index and *S. mutans*/Lactobacillus index and the information was recorded. The examiner was calibrated in all indices prior to the start of treatment. At the baseline, 3 and 6 months digital intraoral photos were

taken. At the 6 month visit the patient was dismissed from the study and continued care with general dentist and treating orthodontist.

Gingival Index: The gingival index rates inflammation from 0-4 depending on the color and texture of the gingival unit. It also rates the plaque quantity from 0-5 after patient rinses with plaque disclosing solution. The index is quick and noninvasive and requires only visual inspection.

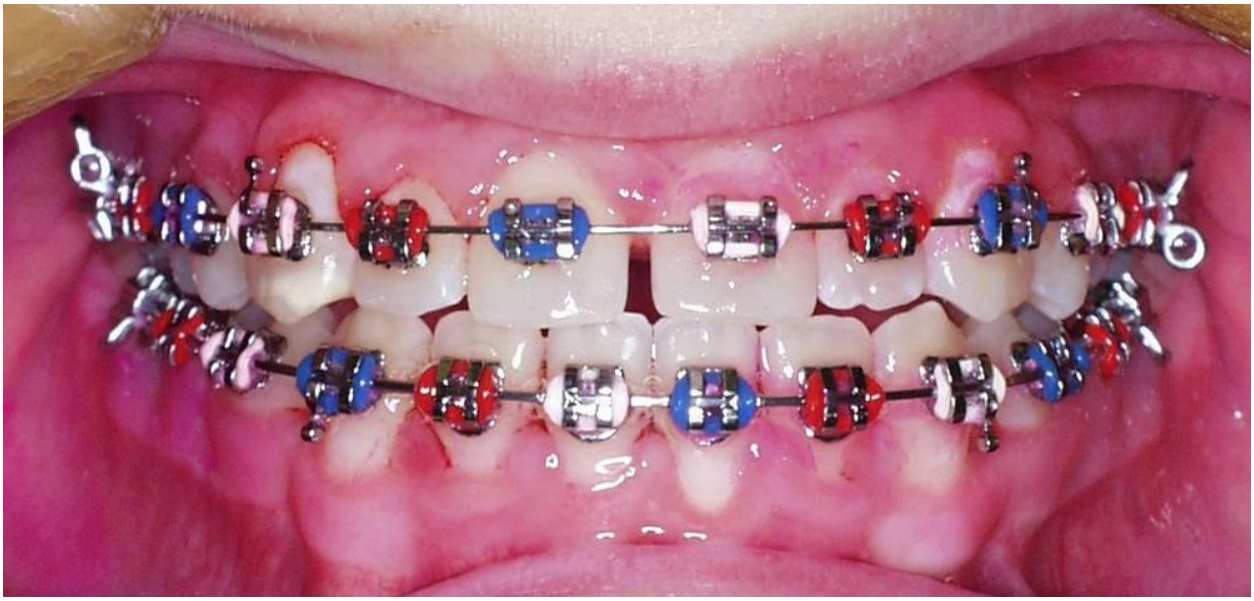

Figure 2-1. Example of gingival tissue rated. Photo courtesy of Timothy Wheeler.

Figure 2-2. Example of Plaque quantity rated. Photo courtesy of Andrew Clark.

Decalcification index: The decalcification index was a modified version of the white spot lesion index of Gorelick et al. The ratings range from 0-4 using both visual and tactile sense.

- 0= No white spot present
- 1= Visible white spots without surface interruption (mild decalcification)
- 2= Visible white spot lesion having a roughened surface but not requiring a restoration (moderate decalcification)
- 3= Visible white spot lesion with surface interruption (severe decalcification)
- 4= Cavitation

Figure 2-3. Example of post-orthodontic decalcification. Photo Courtesy of L. Gorelick.

CRT Bacteria Test: At 3 and 6 month visits saliva was collected from subjects and placed on agar and inserted into a test vial with a $NaHCO_3$ tablet. The vial was then placed into an incubator for 48 hours at 37˚C/ 99˚F. After 48 hours the density of the *S. mutans*/ lactobacilli colonies were compared with evaluation pictures produced by the manufacturer. A finding of 10^5 CFU or more per ml saliva indicates high caries risk.

CHAPTER 3
STATISTICAL ANALYSIS

The data was assumed to be normally distributed leading to the use of parametric statistical tests. We did not test if the data was normally distributed because the sample size was too small to be able to detect non-normalcy. However the data was looked at and appears to be distributed normally. The baseline data between the two groups was analyzed using a Fisher exact test for gender and race and a two sample t-test for age. The PI, GI and DI for the 12 teeth investigated were averaged at each time point. All 3 indices were then analyzed for both groups using a two sample T-test to determine differences between Renew™ and Crest. Also the within group differences were looked at using a paired t-test for both Renew™ and Crest to see if the changes occurred during the study.

CHAPTER 4
RESULTS

The study started with 25 patients but 5 were dismissed from the study. Of the 5 subjects that were dismissed; 1 did not meet inclusion criteria, 1 was placed on MI paste by treating orthodontist, 1 had appliances removed early and 2 did not make appointments. Of the 20 that concluded the study 14 were male and 6 were female. Further race, gender and age demographics are shown in Table 3-1 and Table 3-2. A Fisher exact test was performed and the treatment groups did not differ by gender (p=0) or by race (p=0.47). A two-sample t-test showed that the groups did not differ by age. Table 3-3 and Table 3-4 shows a summary of the results for both treatment group A (Renew™) and treatment group B (Crest®).

Analyzing the baseline data determined no differences either showing the two groups were similar at the start of treatment. Group A and Group B were compared to determine if any differences in the three indices at baseline, 3 months and 6 months. Using a two sample t-test did not find any statistically significant differences in GI, PI and DI at 3 or 6 months.

The within group changes in GI, PI and DI were evaluated and significant results were found. For treatment group A there was a significant change in both PI (p=0.0103) and GI (p=0.0125) at 6 months when compared to baseline. Group B had a significant change in PI (p=0.0186) and GI (p=0.0034) at 6 months as well when compared to baseline. This trend is shown in Figure 3-1 and Figure 3-2 where the baseline on the x-axis is compared to the 6 month score on the y-axis. The dotted line would represent an indices score that was the same at both baseline and 6 months. Since the majority of the points are above the dotted line this shows that the 6 month scores were higher

than at baseline. Additionally there was a significant change in GI (p=0,0044) at 3 months for Group B when compared to baseline. However there was no significant difference in DI at any time point when compared to baseline for either group. This is shown in Figure 3-3 where as compared to PI and GI the majority of the points are near the dotted line indicating the baseline versus 3 and 6 months ratings were similar.

The CRT was analyzed and no differences were seen between the two groups or within the groups.

Table 3-1. Gender and Race Demographics

	Group A	Group B	Total
Male	7	7	14
Female	3	3	6
Caucasian	8	9	17
African American	0	1	1
Hispanic	2	0	2

Table 3-2. Age Distribution

	N	Median	Mean	Std Dev	Max	Min
Group A	10	16.0	17.2	3.9	25	13
Group B	10	14.5	15.0	1.7	18	13

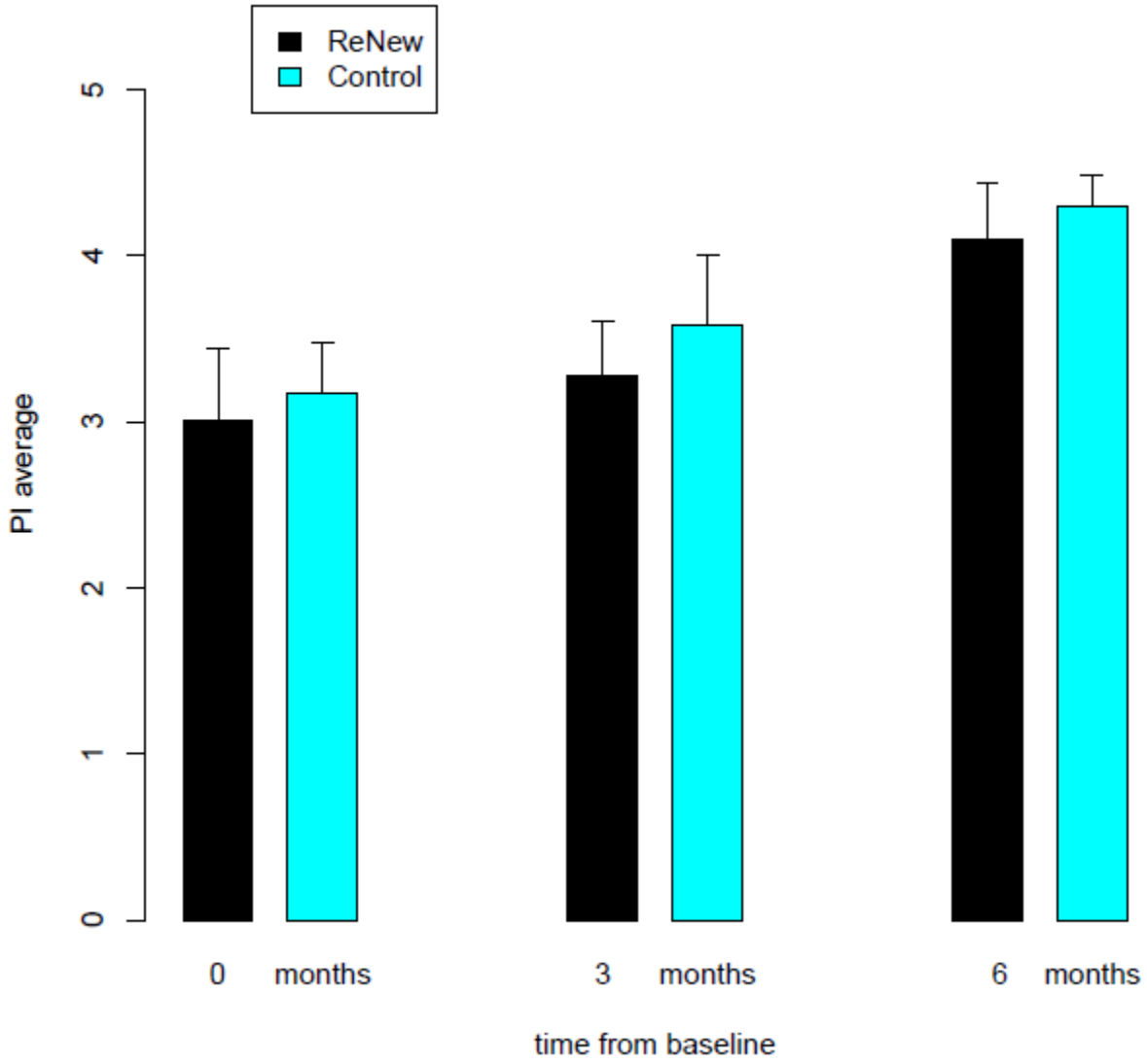

Figure 3-1. Plaque Index (Mean +/- Standard Error)

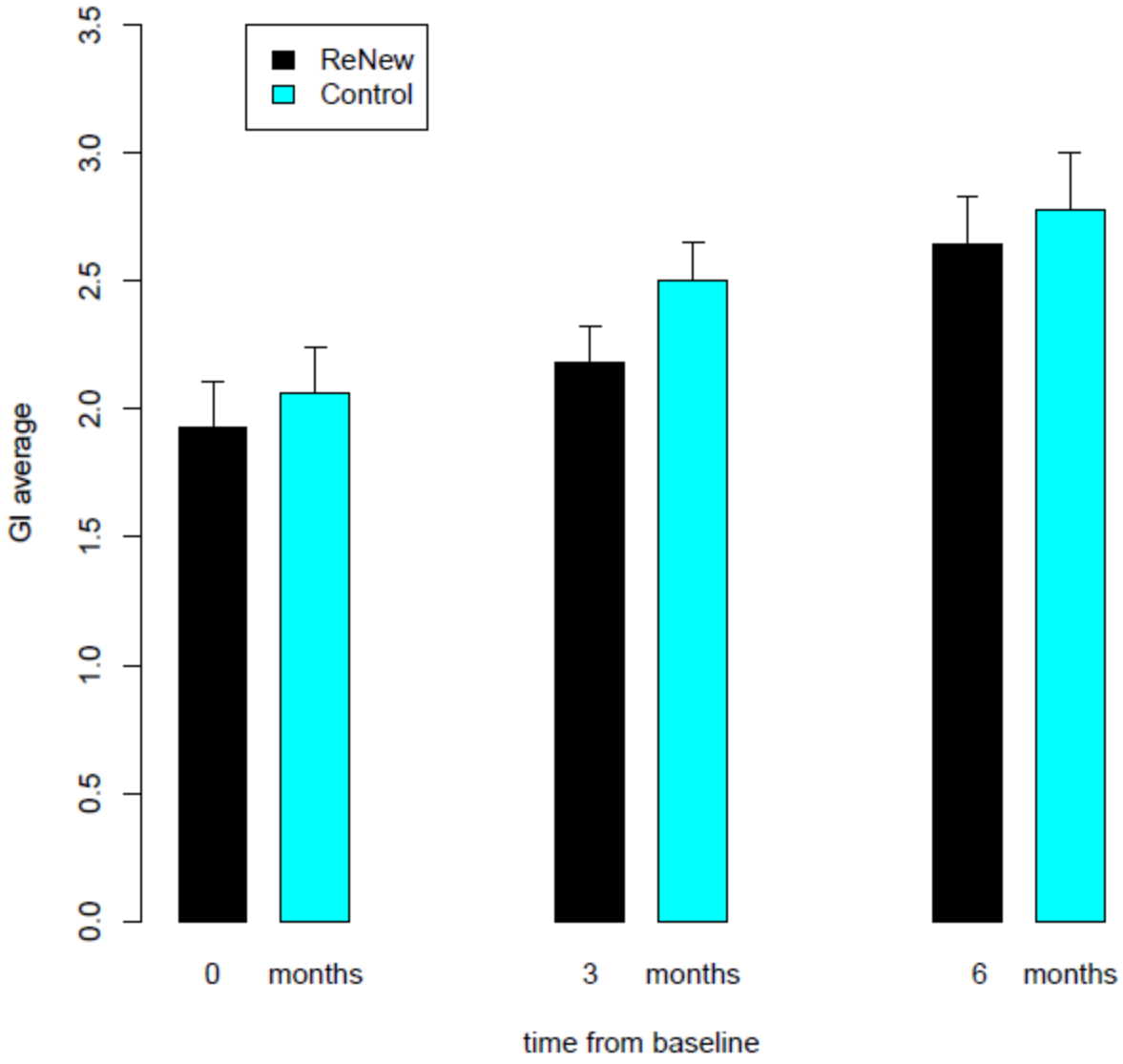

Figure 3-2. Gingival Index (Mean +/- Standard Error)

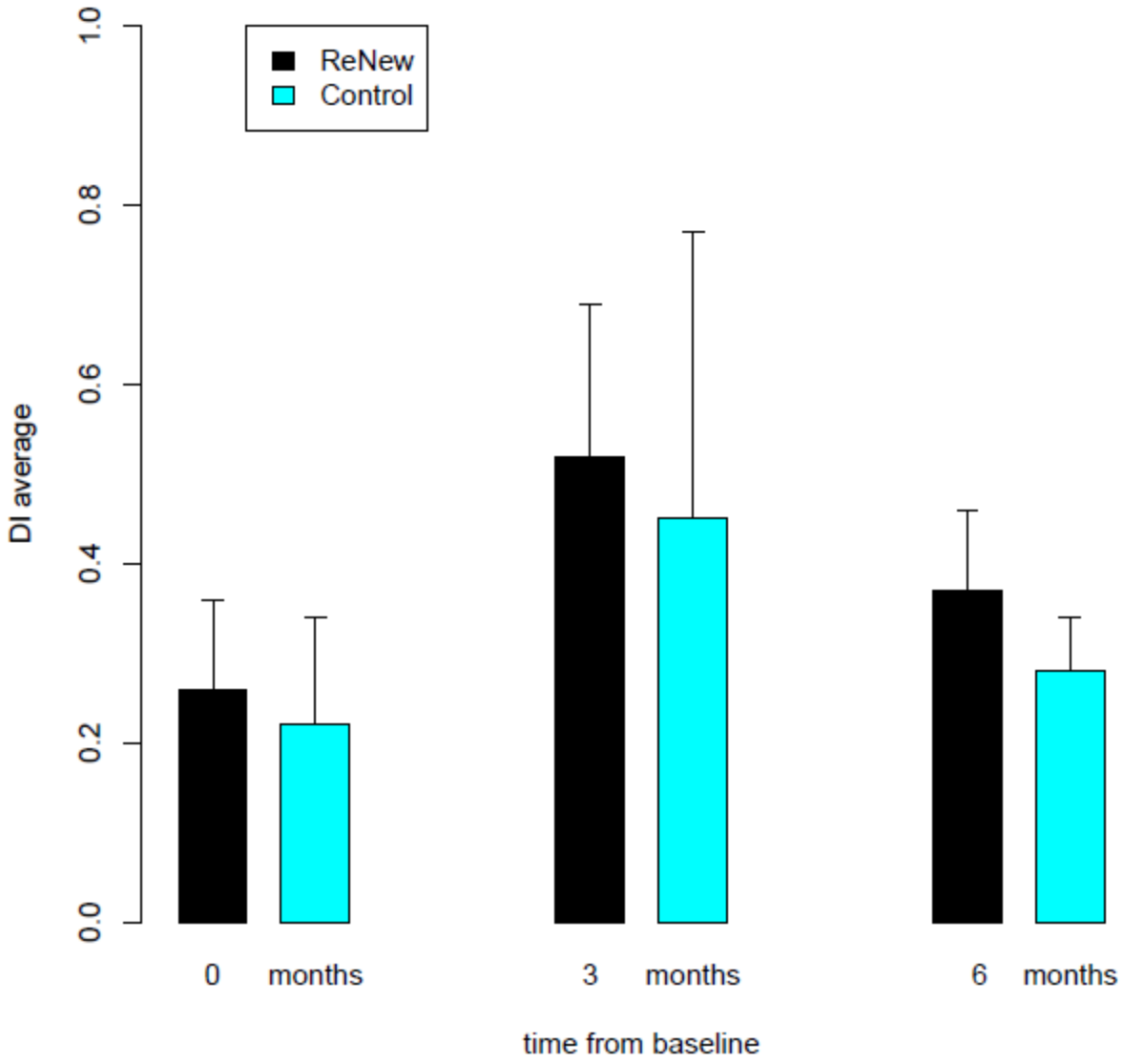

Figure 3-3. Decalcification Index (Mean +/- Standard Error)

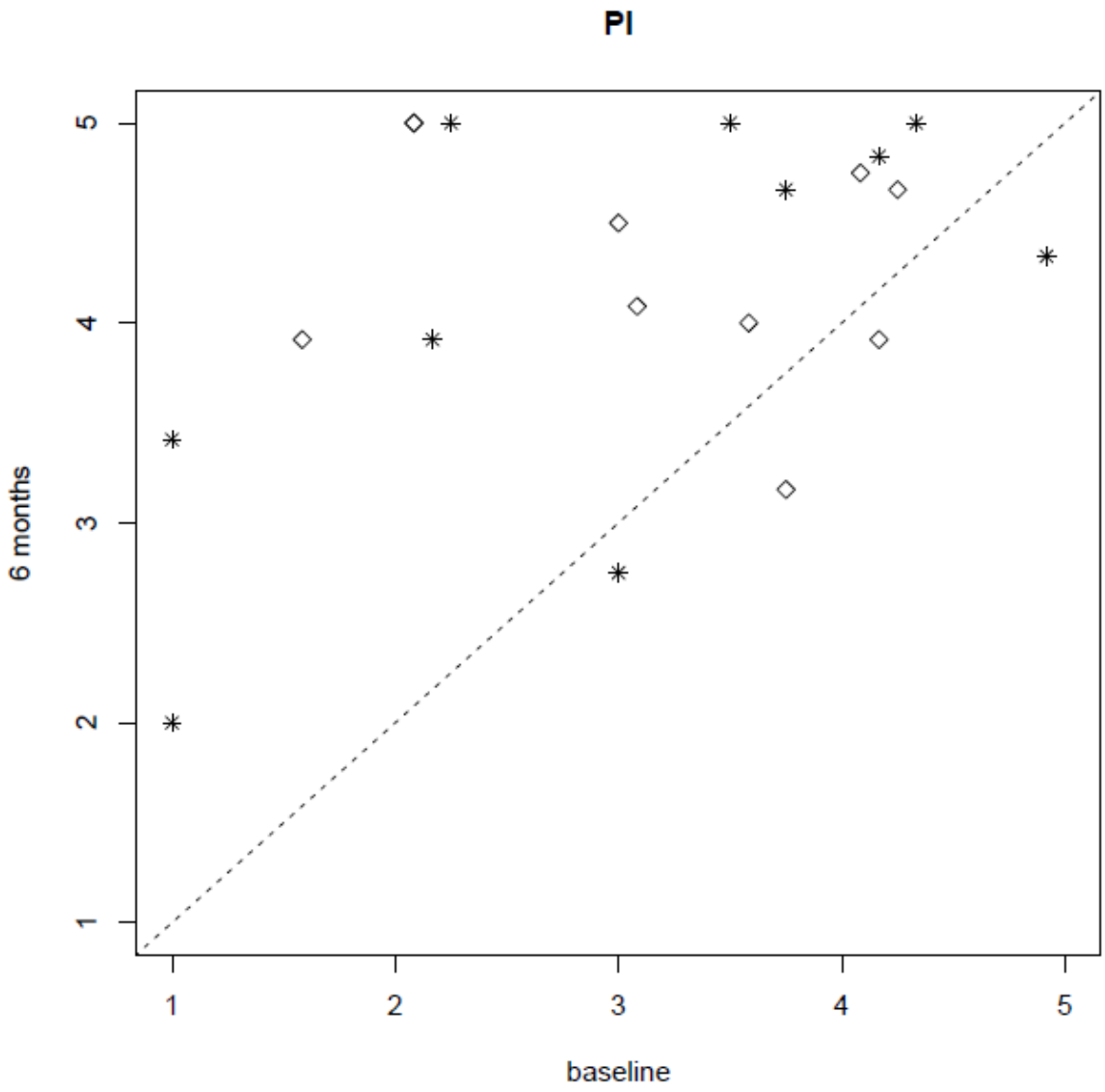

Figure 3-4. Baseline vs. 6 months for PI. *- Renew™, ◊- Crest.

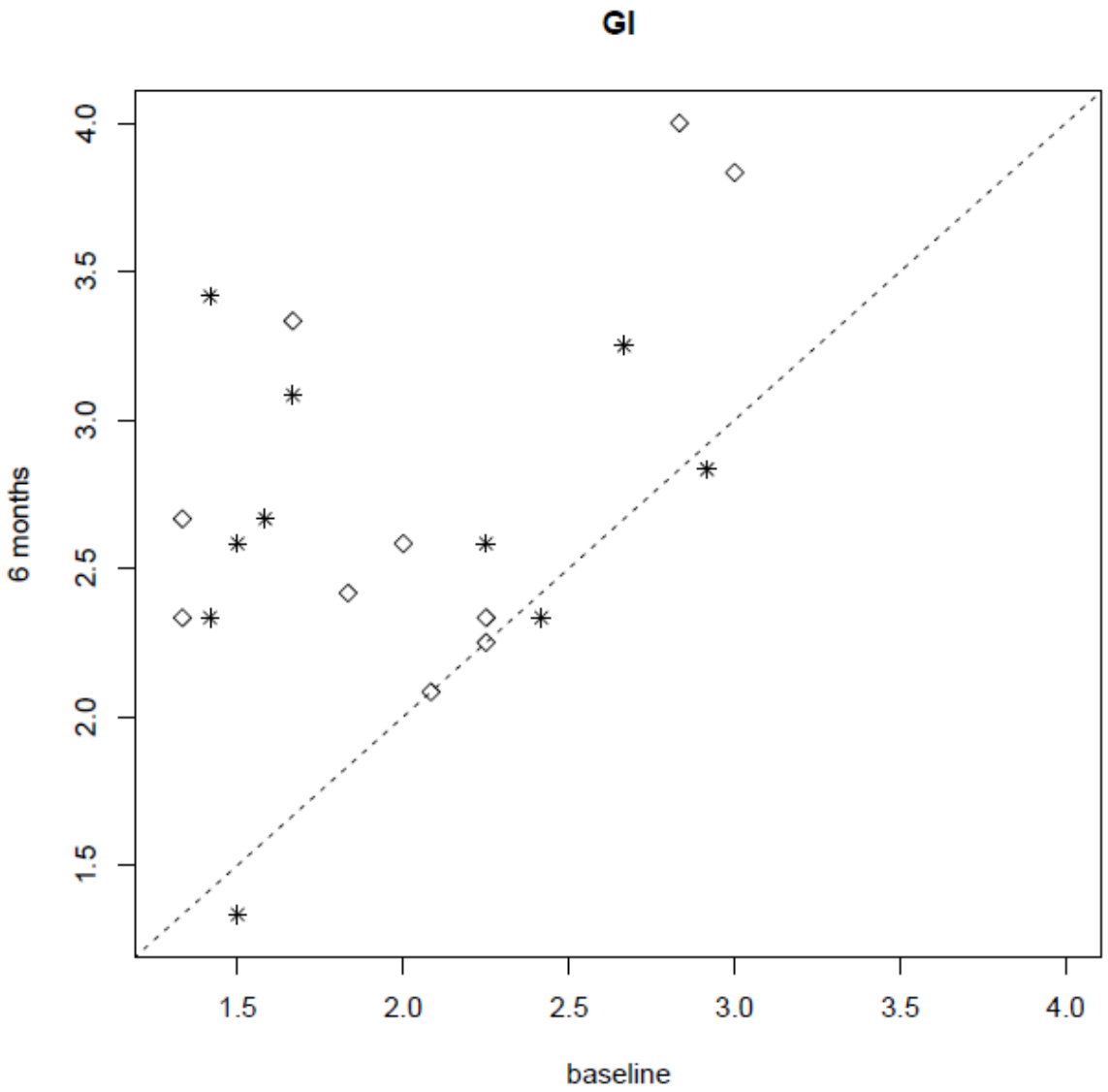

Figure 3-5. Baseline vs. 6 months for GI. *- Renew™, ◊- Crest.

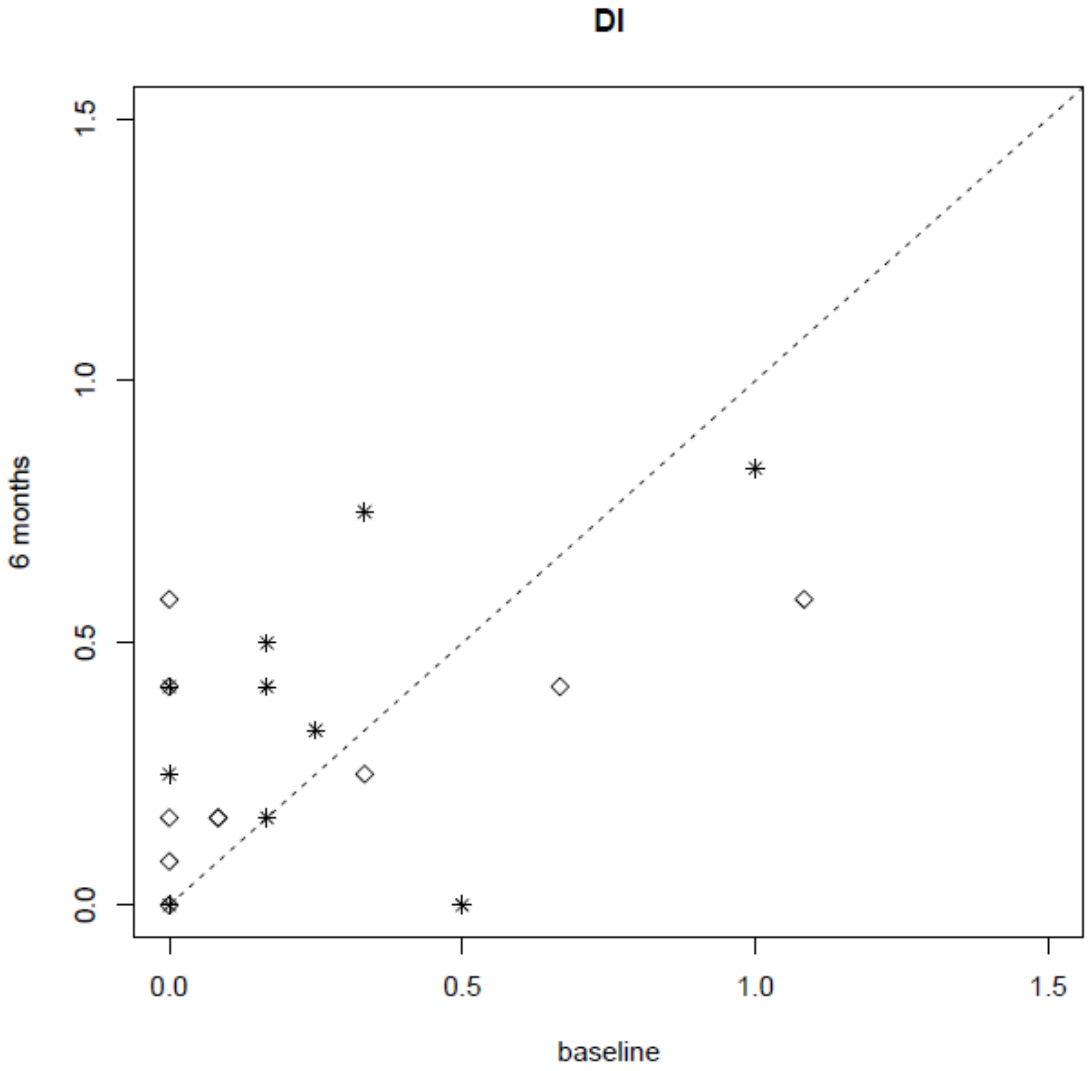

Figure 3-6. Baseline vs. 6 months for DI. *- Renew™, ◊- Crest.

CHAPTER 5
DISCUSSION

WSLs are a common problem in orthodontics and the best treatment for this demineralization is prevention. Once the lesions are present the removal is difficult and often impossible causing an esthetic issue. As shown through the literature having orthodontic appliances increases the likelihood of developing WSLs regardless of patient's oral hygiene ability.[3,4,5,6] Unfortunately not all patients have excellent oral hygiene and as the hygiene ability gets worse the likelihood of getting the WSLs increases. This study investigated subjects rated as having poor oral hygiene by the treating orthodontist increasing their chance of developing WSLs. In this study the patients were shown initially proper brushing technique by the investigators but all reinforcement was done by the treating orthodontist.

As shown above, the data analyzed from this study showed no difference in the PI, GI, DI and CRT between the two experimental groups. From these results it would appear that the Renew™ dentifrice did not have any improvement as compared to the over the counter Crest dentifrice. Possible explanations for this include that the Novamin product in the Renew™ dentifrice may not increase the benefit of fluoride that was present in both dentifrices or that the study sample size was too small to detect significant results. Also due to the small sample size few WSLs developed making it even more difficult to determine a difference between the dentifrices.

Despite the lack of difference between the two dentifrices the overall incidence of WSLs(DI) did not increase although the PI and GI index both increased. The increase in PI and GI show that the oral hygiene of the patients did not improve during treatment

and actually became worse as treatment progressed. This is consistent with the previous findings that even with consistent reinforcement of oral hygiene instructions only 15% of patients are considered to have excellent oral hygiene.[1] Since the plaque and agents that cause demineralization were still present and increased throughout treatment it could be expected that WSLs would increase but this was not found in the study. The constant delivery of both dentifrices by the patient's may have helped to prevent the development of WSLs despite the patient's failure at removal of the plaque. The mechanism of the prevention could be from incorporation of the fluoride present in both dentifrices and the increase in pH and release of calcium and phosphate by the novamin compound present in the Renew™.

Although the study did not find any additional benefit to the use of Renew™ when compared to an over the counter dentifrice, the study did show the importance of the presence of dentifrice in the oral cavity even in the presence of high quantities of plaque. More subjects need to be examined to see if there is a true difference between the dentifrices.

CHAPTER 6
CONCLUSIONS

In conclusion the study found no difference between over the counter Crest dentifrice and Renew™ in the development of WSLs between patients undergoing orthodontic treatment. The study did show the importance of having dentifrice present even if the patient exhibits inadequate oral hygiene ability. Further investigation of the Renew™ is warranted to determine if it is more effective than a common dentifrice.

LIST OF REFERENCES

(1) Bishara, SE, Ostby, AW. White spot lesions: Formation, prevention, and treatment. Seminars in Orthodontics 2008; 14(3): 174-182.

(2) Greenwall, LH. Treatment considerations for bleaching and bonding white lesions in the anterior dentition. The Alpha Omegan 2009; 102(4): 121-127.

(3) Ogaard B. Prevalence of white spot lesions in 19-year-olds: A study on untreated and orthodontically treated persons 5 years after treatment. American Journal of Orthodontics and Dentofacial Orthopedics : Official Publication of the American Association of Orthodontists, its Constituent Societies, and the American Board of Orthodontics 1989; 96(5): 423-427.

(4) Lovrov S, Hertrich K, Hirschfelder U. Enamel demineralization during fixed orthodontic treatment - incidence and correlation to various oral-hygiene parameters. Journal of Orofacial Orthopedics = Fortschritte Der Kieferorthopadie : Organ/official Journal Deutsche Gesellschaft Fur Kieferorthopadie 2007; 68(5): 353-363.

(5) Geiger AM, Gorelick L, Gwinnett A J, & Griswold PG. The effect of a fluoride program on white spot formation during orthodontic treatment. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, its Constituent Societies, and the American Board of Orthodontics 1988; 93(1): 29-37.

(6) Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. American Journal of Orthodontics 1982; 81(2): 93-98.

(7) Pretty IA, Pender N, Edgar WM, Higham SM. The in vitro detection of early enamel de- and re-mineralization adjacent to bonded orthodontic cleats using quantitative light-induced fluorescence. European Journal of Orthodontics 2003; 25(3): 217-223.

(8) Burwell, AK, Litkowski, L J, & Greenspan, DC. Calcium sodium phosphosilicate (NovaMin): Remineralization potential. Advances in Dental Research 2009; 21(1): 35-39.

(9) Andersson, O H, Kangasniemi,I Calcium phosphate formation at the surface of bioactive glass in vitro. Journal of Biomedical Materials Research 1991; 25(8): 1019-1030.

(10) Diamanti I, Koletsi-Kounari H, Mamai-Homata E, Vougiouklakis G. Effect of fluoride and of calcium sodium phosphosilicate toothpastes on pre-softened dentin demineralization and remineralization in vitro. Journal of Dentistry 2010; 38(8): 671-677.

BIOGRAPHICAL SKETCH

Andrew Clark was born and raised in Gainesville, Florida. He graduated from the University of Florida in 2006 with a bachelor's degree in Nutritional Sciences. He then followed his father into the field of dentistry and earned a Doctor of Dental Medicine from the University of Florida in 2010. He also received his Master of Science and a certificate in orthodontics from the University of Florida in the fall of 2012.

Andrew will join a private practice in Gainesville, Florida. He has been married since 2010 to his wife, Langley and they have one child, Leighton, born in 2011.