THE EFFICACY OF RESIN INFILTRATION AND MI PASTE - CPP-ACP'S IN MASKING WHITE SPOT LESIONS

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Abstract

Patients with poor oral hygiene undergoing intervention are more likely to develop decalcification surrounding orthodontic brackets and bands, commonly known as white spot lesions (WSLs) (Behnan et al., 2010, Rodgers et al., 2010). Many times, even after the removal of fixed appliances and natural remineralization, these WSLs are still discernible. This in vitro research's goal was to use spectrophotometric analysis to examine how well two intervention modalities—resin infiltration (RI) and casein phosphopeptide amorphous calcium phosphate (CPP-ACP)—improved light reflectivity and, consequently, the formation of WSLs. Sixty extracted human third molars underwent partial demineralization to produce artificial WSLs, which were then randomly assigned to two treatment groups and an artificial saliva control group. The quantity of light (L*) reflected from each tooth specimen's surfaces was measured prior to and following treatment using a spectrophotometer (VITA Easyshade compact). The rise in L* following treatment revealed statistically significant reflectivity enhancements in all three cohorts. There were no statistically significant variations across the research groups, nevertheless. In the end, WSLs were successfully concealed by the control and both treatment strategies.

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1. Introduction

Individuals look for orthodontic therapy to enhance their dentofacial aesthetics, but sometimes as a side effect of poor oral hygiene throughout intervention, white spot lesions (WSLs), which are zones of decalcification surrounding orthodontic brackets and bands, can develop (Behnan et al., Rogers et al., 2010). Unfortunately, following the removal of fixed appliances and natural remineralization, numerous WSLs are still apparent. Additionally, there are several published studies on the subject of WSL remineralization, however few of those investigations have compared the efficacy of multiple therapies for WSL hiding.

The resin infiltration (RI) technique's goal is to stop enamel lesions by micro-invasively injecting polymerizable low viscosity resin into the intercrystalline gaps of enamel. The extremely calcified pseudointact surface layer of enamel must be removed from a WSL using hydrochloric acid prior it can be penetrated (Kielbassa et al., 2009). The RI can pierce the enamel up to 400 microns, as opposed to dental sealants, that only adhere to the enamel's surface (Paris et al., 2007). Regarding the loss of the surface covering, an investigation on adhesive penetration revealed that only 60 microns of infiltration were required to stop additional demineralization (Davila et al., 1975).

Amorphous calcium and phosphate ions are bound by a nanocluster called casein phosphopeptide amorphous calcium phosphate (CPP-ACP). The excretion of the calcium and phosphate ions results in a supersaturated concentration of ions in the saliva, which precipitates a calcium-phosphate complex onto the damaged tooth surface as the pH of the oral environment decreases (Aimutis, 2004). Although there is inadequate and inconsistent evidence to support its effectiveness, the administration of CPP-ACP in the form of MI Paste (Milk Derived Phosphopeptide Infiltration) may be beneficial as an adjunct in reducing or remineralizing WSLs (Guzman-Armstrong et al., 2010, Tung and Eichmiller, 1999).

The present in vitro research's goal was to use spectrophotometric measurements to examine how well two intervention modalities—resin infiltration (RI) and casein phosphopeptide amorphous calcium phosphate (CPP-ACP)—improved light reflectivity and, consequently, the formation of WSLs. The RI and CPP-ACP groups receiving treatment were contrasted with the control group in order to determine whether there was a statistically significant difference in the way they looked of WSLs (measured by the amount of light reflected from the surfaces of each tooth specimen) before and after therapy.

2. Methodology

The study was carried out at Department of Conservative Dentistry and Endodontics, Sri Siddhartha Dental College and Hospital, Agalakote, Tumkur**.** Previously to the investigation, sixty extracted human permanent molars were obtained, cleaned, and preserved in a 0.1% thymol solution to avoid dehydration (Torres et al., 2010). To stop unintended root degradation brought on by the demineralization procedure, the root surface underneath the cementoenamel junction (CEJ) of each specimen was coated with two layers of an acid-resistant varnish. (Figure 1).

Figure 1: Specimen painted with two coats of acid resistantvarnish after demineralization

Customized jigs were made from vinyl polysiloxane bite registration material (Dentsply® Regisil Rigid VPS) for each tooth specimen in order to improve the accuracy and repeatability of L* estimations. The teeth weren't permitted to dehydrate instead were gently wiped dry. The buccal coronal portion of the sample was contacted by a cylindrical rod that had the exact same diameter as the spectrophotometer's tip. With the rod in position, vinyl polysiloxane formed around the rod and the buccal and occlusal surfaces of the tooth to produce a distinct jig for each specimen. The diameter and length of each cylindrical rod utilised were both the same. Each of the three

categories of control, RI, and CPP-ACP tooth specimens (n=20 each group) were haphazardly created. The samples were assessed using a spectrophotometer (VITA Easyshade® compact) that was calibrated in accordance with the manufacturer's instructions before being demineralized (T0), following demineralization (T1), and after therapy (T2).

Step #	Resin Infiltration Protocol
1	Clean the affected tooth and rinse well
	↓
2	Icon® Etch for 2 minutes
	↓
3	Rinse with water and air dry for 30 seconds
	↓
4	Apply Icon®-dry for thirty seconds
	↓
5	Apply Icon® Infiltrant for three minutes. Remove excess with cotton or with sharp explorer. Light cure for forty seconds
	↓
6	With a new tip, apply Icon® Infiltrant again for one minute. Remove excesswith cotton or with sharp explorer. Light cure for forty seconds
	↓
7	Measure shade after RI treatment

Figure 2. Protocol for the Resin Infiltration Group

Step #	CPP-ACP Protocol
1	Brush manually for 5 seconds using fluoridated toothpaste
	↓
2	Rinse with distilled water
	↓
3	Apply MI Paste® for three minutes
	↓
4	Without rinsing, place specimen into fresh artificial saliva
	↓

5	Repeat daily for four weeks
	↓
6	Measure shade at end of each week

Figure 3. Protocol for the CPP-ACP Group

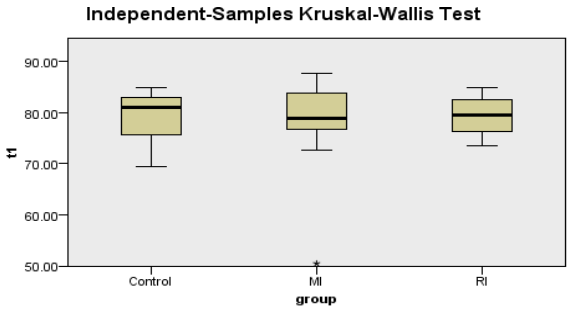
Step #	**Control n=20**	**RI n=20**	**CPP-ACP n=20**
1	Custom jig fabrication	Custom jig fabrication	Custom jig fabrication
	↓	↓	↓
2	Record pre-demineralization shade T_0	Record pre-demineralization shade T_0	Record pre-demineralization shade T_0
	↓	↓	↓
3	Demineralize for 14 days	Demineralize for 14 days	Demineralize for 14 days
	↓	↓	↓
4	Record initial shade after demineralization T_1	Record initial shade after demineralization T_1	Record initial shade after demineralization T_1
	↓	↓	↓
5	Store in artificial salivafor 4 weeks	Resin infiltration application	Daily application of CPP-ACP for 4 weeks
	↓	↓	↓
6	Record final shade T_2 at the end of the 4th week	Record final shade T_2 immediately after RI	Record final shade T_2 at the end of the 4th week

Figure 4. Outline of steps for each of the three groups: Control, RI, and CPP-ACP

Both parametric and nonparametric methods of data analysis were used. All hypothesis tests were two-tailed and carried out using a 0.05 alpha level. With the help of the SAS v9.2 programme (SAS Institute, Cary, NC), statistical analysis was carried out. Both of the MI Paste values (T1 and T2) and one of the RI values (T2 alone) may be regarded as outliers (Figures 7 and 8). The Kruskal-Wallis and Wilcoxon Signed Ranks Tests were employed to ascertain whether there were between-group and within-group differences, respectively, in T1 or T2 values in order to lessen their influence on the statistical analysis. The ranks of the data were subjected to a two factor (1 between, 1 within) mixed model ANOVA to simultaneously adjust for impacts

3. Results

There was no statistically significant between-group variations in T1 or T2 values, according to the outcomes of both the parametric and nonparametric statistical analyses. The L* values (L) within each of the groups did, however, alter in a statistically significant way between T1 and T2 (Figures 9, 10, and 11). In other words, there was a substantial difference in L following treatment in all three groups (Control, RI, and CPP-ACP). The difference between the T2 and T1 values was statistically significant (p .001). Overall of the groups' T1 to T2 differences in L were statistically equivalent (p =.820). Furthermore, no statistically significant difference in T1 or T2 values amongst the groups could be seen (p =.891) (See Table 1).



Total N	60
Test Statistic	.067
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.967

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

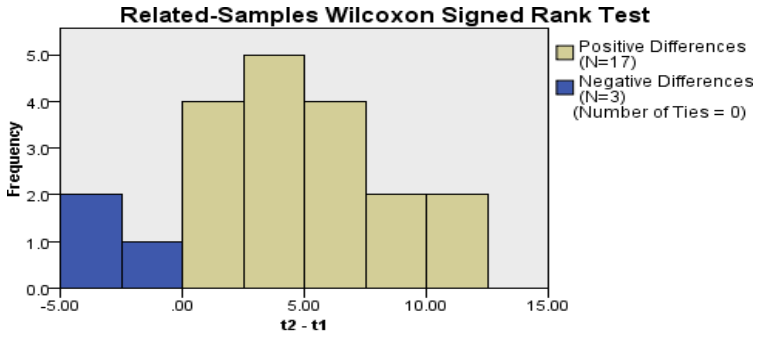
Figure 5. Boxplot of T_1 values of the three groups

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between t1 and t2 equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

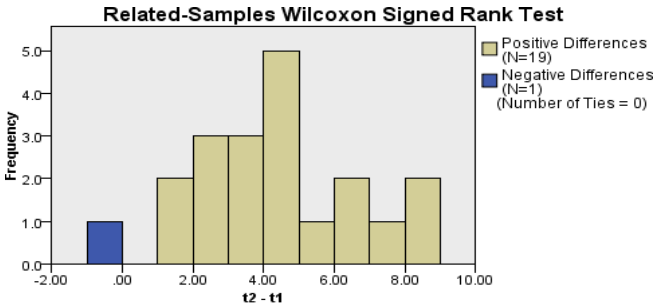
Asymptotic significances are displayed. The significance level is .05.

Figure 6. Boxplot of T_2 values of the three groups



Total N	20
Test Statistic	194.000
Standard Error	26.786
Standardized Test Statistic	3.323
Asymptotic Sig. (2-sided test)	.001

Figure 7: T_1- T_2 difference in the ΔL* values in Control Group



Total N	20
Test Statistic	209.000
Standard Error	26.786
Standardized Test Statistic	3.883
Asymptotic Sig. (2-sided test)	.000

Figure 8: T_1- T_2 difference in the ΔL* values in RI

Table 1: Test of within-subject effects, contrasts and tests of between-subject effects

Tests of Within-Subjects Effects

Source		Type III Sumof Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	34307.008	1	34307.008	92.907	.000
	Greenhouse-Geisser	34307.008	1.000	34307.008	92.907	.000
	Huynh-Feldt	34307.008	1.000	34307.008	92.907	.000
	Lower-bound	34307.008	1.000	34307.008	92.907	.000
time * group	Sphericity Assumed	147.467	2	73.733	.200	.820
	Greenhouse-Geisser	147.467	2.000	73.733	.200	.820
	Huynh-Feldt	147.467	2.000	73.733	.200	.820
	Lower-bound	147.467	2.000	73.733	.200	.820
Error(time)	Sphericity Assumed	21048.025	57	369.264		
	Greenhouse-Geisser	21048.025	57.000	369.264		
	Huynh-Feldt	21048.025	57.000	369.264		
	Lower-bound	21048.025	57.000	369.264		

Tests of Within-Subjects Contrasts

Source		**Type III Sumof Squares**	**df**	**Mean Square**	**F**	**Sig.**

time	Linear	34307.008	1	34307.008	92.907	.000
time * group	Linear	147.467	2	73.733	.200	.820
Error(time)	Linear	21048.025	57	369.264		

Tests of Between-Subjects Effects

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	**439230.000**		**1 439230.000**	**284.110**	**.000**
group	356.850		2 178.425	.115	.891
Error	88121.150		57 1545.985		

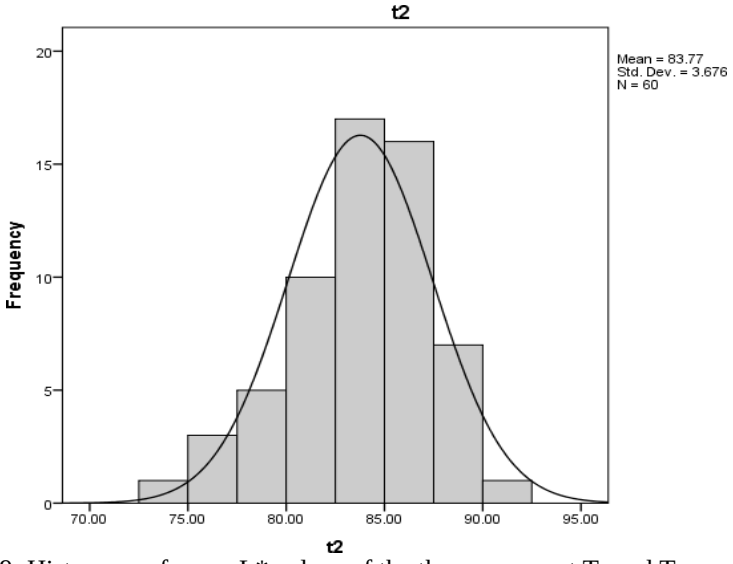


Figure 9: Histogram of mean L* values of the three groups at T_1 and T_2

4. Discussion

Spectrophotometers emit light to an item using fibre optic technology with the goal to quantify the light that is reflected from the object (Corciolani and Vichi, 2006). In a 3-D colour space, the colour of an object can then be quantified (Torres et al., 2011). Only the L* value (0-100) was measured because the goal of this study was to assess the masking impact of WSLs using the lightness scale. Whenever lit by the spectrophotometer, things with lower L* values reflect less light than objects that have greater L* values. This is generally entities with lower L* values absorb, scatter, or transmit more light (Fondriest, 2003).

With increasing mineral loss, the scattering coefficient grew exponentially, by more than two orders of magnitude, according to research by Darling et al. on the light scattering characteristics of naturally and artificially demineralized tooth enamel. Ko et al. observed that demineralization of enamel increased the optical scattering coefficient by a factor of three. They also examined the light scattering of enamel blocks as a consequence of mineral loss. In demineralized teeth, the partial disintegration of individual mineral crystals results in the formation of micropores within the lesion's body. According to Darling et al. (2006), such micropores serve as scattering centres and strongly scatter visible light. As a result, teeth with demineralization have lower L* values than healthy teeth as they disperse light more and reflects it less. According to the study's findings, the average L* readings at time T1 (after demineralization) were actually considerably lower than those at time T0 (the initial time before demineralization). The removed human third molars were demineralized for fourteen days using the recipe for the demineralization solutions offered by the LLU CDR. This procedure was created based on the findings of our pilot investigation. We found that WSLs that were visible and free of surface cavitation of the enamel's outer surface were generated after fourteen days of demineralization. Over the

objective of this investigation, tooth specimens that had been demineralized for more than 14 days displayed cavitated WSLs. The two pre-defined criteria for successful demineralization in this investigation were the decrease in L* value and the sample's appearance as being chalky white. Despite remineralization, a non-cavitated WSL can still be seen clinically and by radiography due to the increased radiolucency and altered physical characteristics. The T2 levels in this investigation came close to, but fell short of, the T0 readings. The potential hiding impact of remineralization is reduced in proportion to the size of the lesion body. According to Gonzalez-Cabezas (2010) and ten Cate et al. (1998), this is caused by a variation in remineralization between the surface of the WSL and the body of the lesion. Despite L* values in all three categories statistically improved from T1 to T2, there was no statistically significant difference in L* values between the groups. The aesthetic look of WSLs was improved in this work by boosting light reflectivity using RI, CPP-ACP, and artificial saliva. This result was different from that of Torres et al. (Torres et al., 2010), who came to the conclusion that RI therapy was superior to artificial saliva. The disparity in findings could have several causes, one of which could be the size of the WSLs produced by the artificial demineralization process. In 2010, Neuhaus et al. found that RI treatment totally concealed minor WSLs. On the other hand, moderate to large WSLs demonstrated aesthetic enhancements following RI but remained evident following therapy. It's possible that the WSLs generated in the present investigation were smaller than the WSLs used in Torres' research. Irrespective of the chosen intervention method, a WSL with a smaller body cavity will probably experience more remineralization than a WSL with a bigger body cavity. Considering the T2 L* levels for all groups were nearly equal to the T0 values, it's possible that RI and CPP-ACP don't have enough remineralization ability to compete with artificial saliva.

5. Conclusion

This in vitro spectrophotometric study's goal was to determine if RI and CPP-ACP were successful in enhancing the look of WSL as measured by elevated optical reflectivity. The statistically substantial increase in L* values from T1 to T2 in this investigation proved the efficacy of RI, CPP-ACP, and artificial saliva in concealing WSLs. Nonetheless weighed against the control group (fake saliva), there was no statistically significant difference in the efficacy of the experimental groups (RI and CPP-ACP). According to the findings of this research, one group's ability to disguise WSLs is not significantly superior to another group's ability to do so. The benefits of RI and CPP-ACP, nonetheless, might go beyond only improving vision. The preventive remineralization benefits of CPP-ACP might outweigh those of artificial saliva. In bigger sized WSLs, RI, a promising minimally invasive treatment, may be more effective at disguising than synthetic saliva. The research's second important conclusion showed that daily CPP-ACP use for two weeks or four weeks produced similar improvements in L* levels. However, prolonged CPP-ACP treatment times may result in further advantages (remineralization, lesions decrease) beyond just the cosmetic improvement in light reflectivity.

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