IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 10 Ser.8 (October. 2019), PP 44-54
www.iosrjournals.org

Comparative Evaluation of the Effect of the Tooth Brushing On the Surface Roughness and Colour Stability of Poly (Methyl Methacrylate) Heat Cure Resin with Application of Denture Sealant

Samin HallajMoghaddam Sarand[1]
[*]Jayakrishna Kumar Sampathkumar[2],[·] *Hariharan Ramakrishnan[3],
*Vallabh Mahadevan[4], [*]Azhagarasan[5]NS
[*] *Professors*
Department of Prosthodontics & Implantology
Ragas Dental College &Hospital, Uthandi, Chennai-600119,Tamilnadu,India
Corresponding author: Hariharan Ramakrishnan, abcv2005@yahoo.com

Abstract
Purpose: *The present in-vitro study was conducted to comparatively evaluate, the effect of brushing on the surface roughness and colour stability of Poly(methyl methacrylate) Heat cure denture base resin after application of surface sealant.*
Materials and Methods: *A total of 20 Poly (methyl methacrylate) Heat cure denture base resin samples of diameter 10mm and thickness of 2 mm were fabricated. The samples were divided into two groups, as uncoated (Group I, n=10) and coated (Group II, n=10) with Denture surface sealant.*
The surface roughness and colour stability of each sample in both the groups were evaluated with a 2D Surface Profilometer and Spectrophotometer respectively. The test samples of both the groups were subjected to brushing using an electronic tooth brush to simulate the brushing effect of one- year duration. The test samples of both the groups, after brushing were evaluated again with a 2D Surface profilometer and Spectrophotometer. The measurements obtained were tabulated and statistically analyzed.
Results: *The mean Ra value for Group I and Group II before brushing was 13.54 and 7.45 respectively. The mean L*, a*, b* values of Group I before brushing was 46.191, 14.759 and -6.621 respectively. The mean L*, a*, b* values of Group II before brushing was 46.89, 13.159 and -5.478.*
The mean Ra value for Group I and Group II after brushing was 55.669 and 8.847 respectively. The mean L, a*, b* values of Group I after brushing was 46.208, 13.829 and -6.978 respectively. The mean L*, a*, b* values of Group II after brushing was 47.099, 12.688 and -6.148 respectively. The ΔE for Group I and Group II was 1.1820 and 1.1700 respectively.*
Conclusion: *The uncoated PMMA samples had exhibited significantly higher surface roughness after brushing compared to that of coated PMMA samples. The brushing had no significant effect on colour stability of both the groups. The coated samples showed lesser colour change compared to uncoated after brushing without any statistical significance. The insignificant change in surface roughness and colour stability of the coated samples after brushing can be attributed to the coating of Palaseal denture surface sealant.*

Key words: ***denture bases, color, polymethylMethacrylate, Profilometer, spectrophotometry, toothbrushing***

Date of Submission: 04-10-2019 Date of Acceptance: 21-10-2019

I. Introduction

Poly (methyl methacrylate) denture base resins had been considered traditional material of choice in the fabrication of removable denture prosthesis over decades mainly due to its ease of manipulation, low cost and acceptable aesthetics. However, it's major limitation such as presence of residual monomer content, poor mechanical properties and dimensionalinstability have prompted researchers to seek for newer denture base materials.[1,2,3]

Alternatives to PMMA denture base resins have been introduced such as polyamide and butadiene PMMA co-polymer which have lower flexural strength and flexural modulus making it semi flexible.[4] Main advantage of polyamide denture base material is its optical properties, which reflects the colour of the base tissue mimicking the natural appearance.[4,5] Lower melting temperature makes polyamide, difficult to finish and polish, producing higher surface roughness when compared to PMMA, both before and after polishing.[6]

Irrespective of the denture base resins used, the presence of surface irregularities and microscopic voids on the restorative material/ restoration significantly affects the properties of the material and thereby limiting its durability. The surfaces of the acrylic dentures, generally acts as a nidus for the biofilm formation and colonisation of microorganisms.[7,8,9]

Surface roughness and surface free energy are important prognostic features for the clinical longevity of dental restorative material.[4,10,11] Rough external surface of dental restoration facilitates plaque adhesion and subsequent aggregation of microorganism and debris, leading to tooth loss due to caries, periodontal disease and also denture stomatitis.[9,10,12,13,14]

Denture hygiene instructions are usually provided to the patients which involves both mechanical and chemical methods.[15,16] The commonly used method is the use of a denture cleansing brush and an abrasive slurry, but this method is found to be ineffective due to patient's lack of motivation.[17,18,19,20] Many a times, the use of brush and abrasive paste leaves scratch marks on the surface of the denture which makes it further prone for collection of debris, stains and tartar.[17,21]

The parameter that is mostly used to quantify surface topography is surface roughness average (Ra). An in vivo study by Bollen et al, have established that increase in Ra value beyond 0.2µm significantly leads to biofilm formation.[3,12,13, 22,23] Many studies have shown that denture brushing causes increase in surface roughness in acrylic resins.

Denture bases consisting of PMMA resins are subject to water sorption, which can alter their mechanical properties. High water sorption and solubility of acrylic denture base resins can have a serious impact on reducing their flexural strength and fatigue limit. Moreover, water sorption and chemical reactivity of acrylic resins are associated with discoloration and subsequently hampering the aesthetic acceptability of dental prosthesis.[24,25,26,27]

Colour stability is an important factor for successful clinical service of a restoration.[28.29.30] The discolouration of dental polymeric materials is directly related to several intrinsic and extrinsic factors such as polymerisation methods, chemical specification, residual monomer content, water sorption, surface roughness and beverages like tea and coffee.[31,32,33] Plaque formation and discolouration can be reduced by polishing the denture surface and the teeth.

The finishing and polishing of dental prosthesis are essential steps in removable prosthodontics that enhances aesthetics and the clinical durability of dentures. It is normally carried out in the laboratory with Al2O3 paste and liquid. Mechanical polishing is considered to be superior, but it involves sequential steps and is time consuming.[10,17]

To overcome the limitation of mechanical polishing, an alternative polishing technique was suggested wherein, the prosthesis is immersed in a heated methyl-methacrylate monomer bath (75º c) for 10s.[17,19,34] The superiority of this technique is that it eliminates the conventional polishing technique.

The application of surface sealant agents has been suggested to eliminate the surface defects and improve stain and wear resistance. [31,35] The surface sealant are unfilled resins, primarily used to fill the microstructural defects, that are left after the finishing procedures on denture base resins. Studies conducted to evaluate the effect of surface sealant or glaze materials on denture base materials have provided better results with respect to surface roughness and colour stability.[9,31,36] However, coating of surface sealant agents can lead to situations like low resistance to abrasion, weak bonding to the underlying resin material and poor wetting of the surface due to its high viscous nature.

Quantitative analysis of colour coordinates using CIE lab colour system with spectrophotometer have been universally employed in the dental fraternity and is regarded as standard in evaluating the colour parameters.[3, 9,25, 31,36] Different ΔE values are used to compare differences in colour. ΔE values ≤ 1is considered undetectable by the human eye. Various studies have used different ΔE values as clinically acceptable. Perceptibility threshold was set at $\Delta E \leq 1.30$ units and clinical acceptability threshold was set at $\Delta E \leq 2.25$ units.

Roughness parameters can be analysed using either 2D /3D surface profilometer.[3,9,31,37] Various measurements of surface roughness can be obtained with Ra, which is the arithmetic mean height measurement which is commonly used universal roughness parameter. Profilometers can be used to compare the same surface in different times and different levels of wear and are classified as contact or non-contact. In the present study, 2D contact surface profilometry was employed to evaluate the surface topography of PMMA denture base resin. The instrument contains a stylus which physically contacts the surface of the samples, while recording its texture.

The advantages of 2D surface profilometric instrument include its acceptance, surface independence, resolution, and direct technique with no modelling required. Contacting the surface is often an advantage in contaminated surfaces where non-contact methods (optical methods) can end up measuring surface contaminants instead of the surface itself. Because the stylus is in contact with the surface, this method is not sensitive to surface reflectance or colour.[38]

Earlier studies have evaluated the sealing efficiency of several sealant agents on different restorative materials[3,9,31] Studies evaluating the surface topography and optical properties of PMMA denture base resins following application of sealant agents are available. Studies pertaining to the effect of surface sealant on acrylic resins following mechanical denture cleansing are very few.[39]

Since, the surface topography and colour stability are important requisites with regards to patient's expectation, the introduction of surface glazing agents have proved to be beneficial in optimising the surface texture and colour stability. However, in vitro studies comparing the effect of surface sealant agent over PMMA denture base resins are very limited.

In view of the above, the present in vitro study was conducted to comparatively evaluate the effect of brushing on surface roughness and colour stability of PMMA Heat cure denture base resin with the application of denture surface sealant. The null hypothesis of the present study is that the effect of brushing on PMMA denture base resins before and after application of surface sealant agent will not have any significant difference on the surface topography and colour stability.

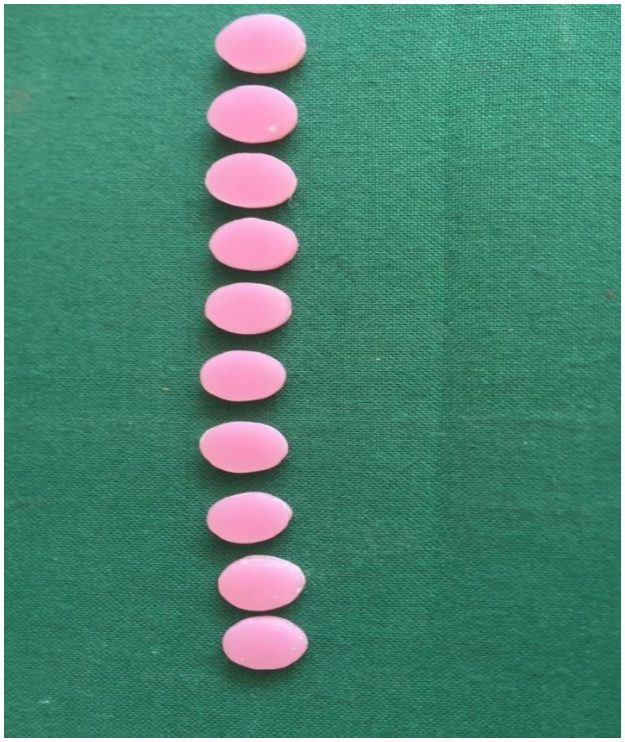
II. Materials And Methods

A custom made metallic mould was made to obtain the disc shaped wax (Hindustan Modelling Wax, Hyderabad, India) patterns of size 10x2mm. Modelling wax was melted and poured into the mould and was allowed to set. The set wax of size 10x2mm was then removed from the mould. The process was repeated to prepare 20 wax patterns.

Accurately weighed dental plaster (Dental grade) was mixed in water with a water powder ratio of 0.45 using a vacuum mixer for 25 seconds and mix was poured in the lid of a dental flask and the wax patterns were invested. The plaster was allowed to set for 30 minutes after which cold mould seal (DPI, India) was applied using a camel hair brush and the second pour was done, by mixing the plaster in water as already mentioned, and was allowed to set.Upon completion of the setting process, after 30 minutes, the denture flask was immersed in boiling water for 4 minutes. The flask was then removed from the water, and appropriate segments were separated. The residual wax sticking on to the mould cavity was carefully removed using hot water. The mould cavity was then cleaned with mild detergent solution and rinsed with boiling water

Cold mould seal was applied onto the mould cavity, preventing pooling of the solution and the solution was permitted to dry. PMMA Heat cure denture base resin (DPI, India) was mixed in the polymer to monomer ratio of 3:1 by volume in a porcelain mixing jar and was allowed to reach the dough like consistency. The resin was then removed from the mixing jar and placed into the mould cavity. A polyethylene sheet was placed over the resin and the flask was reassembled. The flask assembly was then placed into a specially designed press and pressure was applied incrementally, until the denture flask was firmly closed. The flask portions were then separated, and the polyethylene packing sheet was removed, and flash was eliminated. Repeated trial closures were done placing polyethylene sheets until no flash was observed, after which definitive closure of the flask was done without polyethylene sheet. The flask was maintained under pressure until bench curing was complete. The flask was then placed in acrylizer(Confident dental equipment limited) in a constant temperature water bath maintained at 74 degree Celsius for 8 hours. Following the completion of polymerization cycle, the flasks were cooled slowly to room temperature.

The segments of the completely cooled flask were separated, and the samples were retrieved from the mould cavity. Tungsten carbide bur mounted on a laboratory lathe (Suguna motors, India) was used for bulk reduction after which acrylic burs and sand paper were used for contouring. Rubber point was used to remove the scratches. Wet pumice applied to rag wheel was used for final polishing of the samples. The polished samples were segregated and storedin labelled boxes containing water.

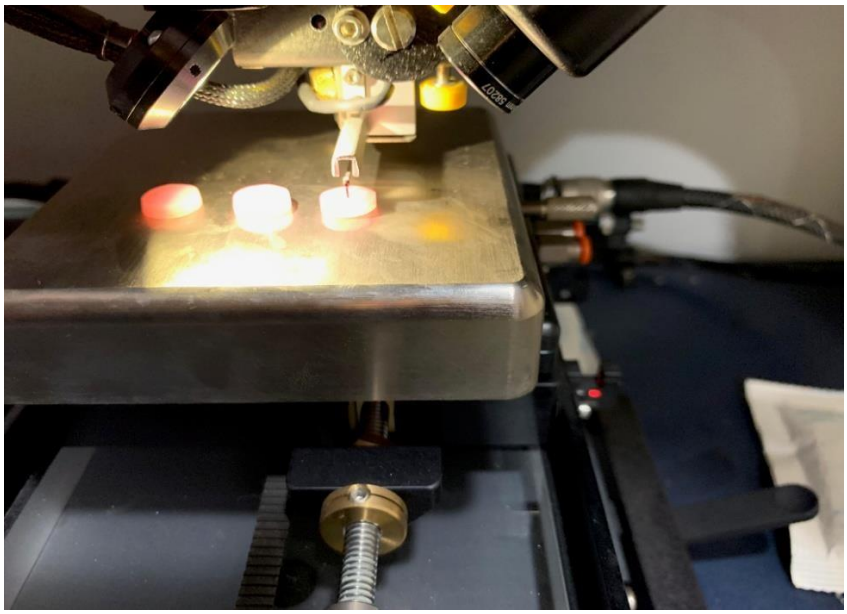


(**Fig 1)** PMMA Heat cure denture base resin samples (ungrouped).

Ten samples were blow dried using a hair dryer. The dried samples were coated with Denture surface sealant (Palaseal)

(**Fig 2)** Denture surface sealant (Palaseal)

Usingapplicators stick in an even, thin layer unidirectional, avoiding any air bubble formation. 20 seconds later, each sample was polymerized individually for 90 seconds in a light polymerizing unit (3M, ESPE)
20 PMMA heat cure denture base material samples were then divided into two groups
GROUP I - PMMA heat cure denture base material – uncoated (10 no)
GROUP II - PMMA heat cure denture base material – coated with denture surface sealant agent (10 no)
Surface roughness, Ra values of the samples were evaluated using 2D surface profilometer (Dektak XT Stylus Profiler, Bruker)



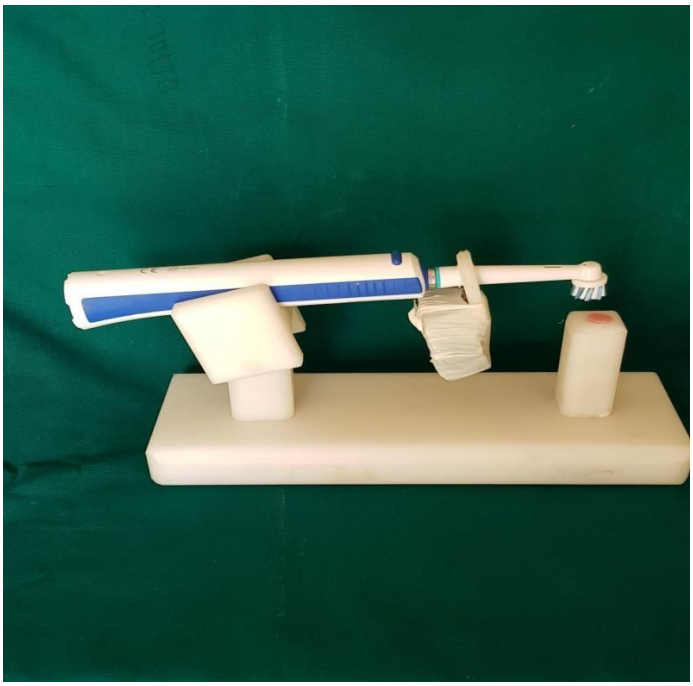
(Fig 3) 2D Surface profilometer

The samples were dried using a hair dryer and placed on the specimen platform. A pick-up with a stylus was traversed over each sample at a constant velocity. The tip, attached to a cantilever, was drawn across each sample in the X direction. For each sample 3 measurements were made, and the arithmetic mean value was calculated for statistical analysis. The measurement range and scan duration selected for thickness measurement were 2mm and 20s, respectively. Vertical movements of the cantilever were registered in a digital signal, and a profile of the surface of each sample was recorded.

CM-3600d Spectrophotometer was used to measure the Commission International de I'Eclairage (CIE) colour parameters L*, a*, b* of each sample in wavelength 360-740 nm using D 65 Illuminant and observer function at 10◦. The samples were dried using a hair dryer and held against the aperture using the sample holder

(**Fig 4)** Spectrophotometer

A custom-made brushing apparatus was designed and built for this study. An electronic tooth brush (PRO 600, Oral B) was fixed in horizontal position over a plastic holder and secured onto a flat base. The brush was operated at 48,000 rpm. A weight of 200gm was suspended from the shank of the brush. A small well was built to retain the samples in contact with the brush head during brushing. The brush was fixed so that the brush head position was consistent between samples and was fully charged each time. The brush head was replaced for a new one every 5 samples within the same group. To simulate one year of wear a total of20min brushing per sample was undertaken



(Fig 5) Brushing cycle – customized brush stand with electronic tooth brush and sample

On completion of the brushing cycles, surface roughness, Ra values of the samples were evaluated using 2D surface profilometer. CM-3600d Spectrophotometer was used to measure the Commission International de I'Eclairage (CIE) colour parameters L*, a*, b* of each sample
The results obtained were tabulated and the data was subjected to statistical analysis using the SPSS-16 software version 20.0, using Independent T test and Paired T test

III. Results

Comparative evaluation of surface roughness of uncoated (Group I) and coated (Group II) samples before brushing done using Independent t test shows that surface roughness of uncoated samples (Group I), before brushing is significantly higher compared to the surface roughness of coated sample (Group II). (Table 1)

TABLE 1 - COMPARITIVE EVALUATION OF SURFACE ROUGHNESS OF UNCOATED (Group I) and COATED (Group II) PMMA HEAT CURE DENTURE BASE RESIN SAMPLES BEFORE BRUSHING USING INDEPENDENT T TEST

S.NO	NO OF SAMPLES	MEAN SURFACE ROUGHNESS BEFORE BRUSHING	STANDARD DEVIATION	P Value
GROUP I	10	31.5400	7.48531	.000 (<0.001**)
GROUP II	10	7.4557	3.86292	

INFERENCE
P Value is .000 (<0.001**)
This implies that surface roughness of uncoated samples (Group I), before brushing is significantly higher compared to the surface roughness of coated sample (Group II).

Comparative evaluation of surface roughness of uncoated (Group I) and coated (Group II) after brushing done using Independent t test shows that surface roughness of uncoated samples (Group I), after brushing is significantly higher compared to the surface roughness ofcoated (Group II) sample. (Table 2)

TABLE 2 - COMPARITIVE EVALUATION OF SURFACE ROUGHNESS OF UNCOATED (Group I) and COATED (Group II) PMMA HEAT CURE DENTURE BASE RESIN SAMPLES AFTER BRUSHING USING INDEPENDENT T TEST

S.NO	NO OF SAMPLES	MEAN SURFACE ROUGHNESS AFTER BRUSHING	STANDARD DEVIATION	P Value
GROUP I	10	55.6690	11.97159	.000 (<0.001**)
GROUP II	10	8.8470	3.14684	

INFERENCE
P Value is .000 (<0.001**)
This implies that surface roughness of uncoated samples (Group I), after brushing is significantly higher compared to the surface roughness of coated sample (Group II).

Comparative evaluation of surface roughness of uncoated samples (Group I) before and after brushing using paired t test is surface roughness (Ra) of the uncoated samples (Group I),after brushing was significantly higher than the surface roughness (Ra) of the uncoated samples (Group II) (Table 3)

TABLE 3- COMPARITIVE EVALUATION OF SURFACE ROUGHNESS OF UNCOATED PMMA HEAT CURE DENTURE BASE RESIN SAMPLES BEFORE AND AFTER BRUSHING USING PAIRED T TEST – GROUP I

		NO OF SAMPLES	MEAN	STANDARD DEVIATION	P VALUE
GROUP I	BEFORE BRUSHING	10	31.5400	7.48531	.002**
	AFTER BRUSHING	10	55.6690	11.97159	

INFERENCE
P value is between 0.000 to 0.010.
This implies that it is significant at level 1 (highly significant)
The above table implies that average surface roughness (Ra) of the uncoated samples (Group I) was significantly high than the average surface roughness (Ra) of the uncoated samples (Group II) after brushing.

Comparative evaluation of surface roughness of coated samples (Group II) before and after brushing using paired t test implies that surface roughness (Ra) of the coated samples (Group II), after brushing was not significantly higher(Table 4)

TABLE 4 – COMPARITIVE EVALUATION OF SURFACE ROUGHNESS OF COATED PMMA HEAT CURE DENTURE BASE RESIN SAMPLES BEFORE AND AFTER BRUSHING USING PAIRED SAMPLE TEST – GROUP II

		NO OF SAMPLES	MEAN	STANDARD DEVIATION	P VALUE
GROUP II	BEFORE BRUSHING	10	7.4557	3.86292	.387
	AFTER BRUSHING	10	8.8470	3.14684	

INFERENCE
P value is between 0.051 to 1.000.
This implies that it is Not Significant at 5 levels (Not Significant)
The above table implies that average surface roughness (Ra) of the coated samples (Group II) was not significantly high than the average surface roughness (Ra) of the coated (Group II) samples after brushing than the average surface roughness (Ra) of the coated (Group II) samples.
Comparative evaluation of the colour stability (ΔE) of the uncoated (Group I) and coated (Group II) samples done using independent t test show that, the colour stability of the uncoated samples (Group I), after brushing was not significantly different from the colour stability (ΔE) of the coated samples (Group II). (Table 5)

TABLE – 5 STATISTICAL COMPARISON OF COLOUR STABILITY OF UNCOATED (GROUP I) AND COATED (GROUP II) PMMA HEAT CURE DENTURE BASE RESIN SAMPLES BEFORE AND AFTER BRUSHING USING INDEPENDENT T TEST.

	GROUP	NO OF SAMPLES	MEAN	STANDARD DEVIATION	P VALUE
COLOUR DIFFERENCE	GROUP 1	10	1.1820	.59342	.962
	GROUP 2	10	1.1700	.52330	.962

INFERENCE
In Group I and Group II, P value is between 0.051 to 1.000.
This implies Not Significant at 5 levels (Not Significant).
The above table implies that the color stability (ΔE) of the uncoated samples (Group I) was not significantly different from the color stability (ΔE) of the coated samples (Group II) after brushing.

IV. Discussion

Poly (methyl methacrylate) resin has been used in the fabrication of denture bases for partial and complete removable dental prostheses since 1936. Despite having some limitations pertaining to its dimensional stability, mechanical properties and residual monomer content, it is still considered the material of choice in the construction of removable complete dentures.

The longevity of any dental restoration mainly relies on the properties of the biomaterials used. With respect to PMMA certain features requires thorough evaluation. However, there are some features of the PMMA resins that are yet to be studied to enhance the longevity of the restoration. Surface roughness and colour stability of the denture base resin are important parameters essential for the durability of the restorative material. Rough surface of a restoration can be a source of discomfort to the patient, as rough substrate can invite deposition of bio film and act as a matrix for microbial growth. Moreover, rough areas on the denture surface are prone for surface staining.Studies[40] has shown that patients were able to detect surface roughness as low as 0.5μm on the restoration intraoral. Thus, it is mandatory that the dental prostheses are delivered with highly polished smooth surface to enhance patient comfort.

Though a denture may be delivered with very high level of polish and lustre, surface topography gets altered during denture service. Denture hygiene and maintenance instructions are given to the patients at the time of denture insertion. Denture cleansing can be done by both mechanical and chemical methods. However, the most commonly followed method is use of denture cleansing brush and abrasives. Studies have indicated that long term use of tooth brush and abrasive paste leads to the formation of scratches leading to increased roughness on the denture surfaces.[15]the surface roughness thus produced, makes denture prone for accumulation of plaque and food stains, leaving denture cleaning more difficult for patient. Surface roughness is also directly related to the colour stability of the PMMA Heat cure acrylic denture base resin. As the surface roughness increases, colour stability decreases thus affecting the aesthetics of the denture. As the denture base material is expected to mimic the oral mucosa, it is important that the colour stability of the material is satisfactory in long term use.

Studies have set a standard threshold value for surface roughness at 0.2 □m Ra[22]. ΔE values ≤1is considered undetectable by the human eye. Various studies have used different ΔE values as clinically acceptable. Perceptibility threshold was set at $\Delta E \leq 1.30$ units and clinical acceptability threshold was set at $\Delta E \leq 2.25$ units. Various studies have been conducted in order to improve the surface smoothness and colour stability of denture base materials. Dental laboratories are advised strictly adhere to polishing protocols. Patients are motivated to follow proper maintenance procedures. Alternatives to mechanical denture cleansing methods are being developed and brought into practice.

The application of denture surface sealants has been developed and is claimed to reduce surface roughness and maintain colour stability. The surface sealants are basically unfilled resins, primarily used to fill the micro structuraldefects, which are left after the finishing procedures on denture base resins.

The present in vitro study was conducted to comparatively evaluate, the effect of brushing on the surface roughness and colour stability of Poly (methyl methacrylate) Heat cure denture base resin after application of denture surface sealant. The results of the above study revealed that Denture surface sealant application reduces the surface roughness that may be produced by mechanical cleansing procedure such as brushing, though it does not have any effect on colour stability of PMMA Heat cure denture base resin.

The mean surface roughness of the uncoated PMMA Heat cure denture base resin samples (Group I), before brushing was 13.54 and the mean surface roughness of the PMMA Heat cure denture base resin samples coated with Denture surface sealant (Group II), before brushing was 7.45.On completion of brushing cycles, simulating one year's brushing the mean surface roughness of uncoated PMMA Heat cure denture base resin samples (Group I) increased to 55.669, while the mean surface roughness of PMMA Heat cure denture base resin coated with Denture surface sealant (Group II) increased to 8.847.Thus, the uncoated PMMA Heat cure

denture base resin samples (Group I) showed an increase of 4.13% in surface roughness, while PMMA Heat cure denture base resin coated with Denture surface sealant (Group II) showed an increase of only 1.18% in surface roughness after one year's brushing.

Statistical comparison of the mean surface roughness between Group I and Group II using independent T test and Paired T test reveals significantly high surface roughness in Group I (p value .002**)The reduction in surface roughness in Group II samples (PMMA Heat cure denture base resin samples coated with Denture surface sealant) can be attributed to the coating with Denture surface sealant, which fills the micro gaps that forms on the surface of the denture base resin, after finishing and polishing. The denture surface sealant forms a layer approximately 100 -150 μm thick and increases the surface hardness of the denture base resin, making it resistant to abrasion.

The result thus obtained is in accordance with the study conducted by Dede et al[36], in which he studied the effect of sealant agents on the colour stability and surface roughness of nanohybrid composite resins. His study showed reduced surface roughness in samples coated with Palaseal surface sealant agent. A study conducted by Santos[39], in which the effect of Parylene coating on the surface roughness of PMMA Heat cure denture base resin after brushing was evaluated showed that samples coated with Parylene had reduced surface roughness after simulating one year's brushing. The result obtained in the present study is also in compliance with Santos's study. Thus, it can be inferred that surface treatment procedures such as coating the PMMA Heat cure denture base resin using Denture surface sealants, helps to increase the wear resistance of the resin by filling the micro fissures and micro defects that forms after finishing and polishing procedure by capillary action.

Colour changes in denture base resin materials can be due to various intrinsic and extrinsic factors like polymerization methods, chemical specifications, residual monomer content, water sorption, surface roughness and food stains. It is essential that the colour of the denture delivered to the patient is maintained aesthetically in long term use. In the present study, the mean L*, a* b* values of uncoated samples of PMMA Heat cure denture base resin obtained before brushing was 46.191, 14.759 and -6.621 respectively. Their mean L*, a*, b* values obtained after completion of brushing cycle, simulating one year of brushing was 46.208, 13.829 and -6.978 respectively. The mean ΔE was 1.1820. The mean L*, a* b* values of PMMA Heat cure denture base resin samples coated with Denture surface sealant obtained before brushing was 46.89, 13.159 and -5.478 respectively. Their mean L*, a*, b* values obtained after completion of brushing cycle, simulating one year of brushing was 47.099, 12.688 and -6.148 respectively. The mean ΔE was 1.1700.

Statistical comparison of mean Δ E values between Group I and Group II reveals no significant difference. (p value .962). Thus, the study reveals that the colour stability of PMMA Heat cure denture base resin is satisfactory for short term use and that coating of the denture base resin with denture surface sealant has no significant effect on the colour parameters.

This result is in conflict with the study conducted by Sahin ET al[3, 9], in which the effect of sealant agents on the surface roughness and colour stability of denture base materials was studied. The study showed that denture base resins coated with palaseal denture surface sealant when immersed in coffee for a period of 7 days showed visually perceptible colour difference, though it was in a clinically acceptable range.

Thus, it can be concluded that denture surface sealant are resistant to discolouration that may be induced by surface roughness but not to staining that may be caused by food products. This aspect of Denture surface sealant needs further research. The results observed in the present study showed insignificant changes in the surface roughness and colour stability of the coated samples after brushing. Hence, the null hypothesis is not validated.

The present in vitro study had some limitations. Only one denture base resin and surface sealant were evaluated. Results would have been more predictable when newer denture base materials such as milled PMMA, polyamide, PEEK etc and different surface sealant agents were compared with PMMA resin. In the present study brushing cycle was limited to one-year duration and no staining solution was used to simulate intraoral conditions. Further research is required to evaluate the long-term service of sealant agent on Candida growth. Optical properties and wear resistance needs to be compared with different laboratory and chair side polishing techniques.

V. Conclusions

Within the limitations of the study, the following conclusions were drawn,

1. Application of Denture surface sealant reduces the surface roughness of PMMA Heat cure denture base resin samples by filling the micro defects that might be produced during finishing and polishing.
2. Application of Denture surface sealant on PMMA Heat cure denture base resin samples will help to reduce the surface roughness that might be produced by mechanical cleansing procedure by increasing the wear resistance of the denture base resin.

3. Application of denture surface sealant on PMMA Heat cure denture base resin has no effect on colour stability of the resin.

References

[1]. Berger JC, Driscoll CF, Romberg E, Luo Q, Thompson G. Surface roughness of denture base acrylic resins after processing and after polishing. J Prosthodont 2006; 15:180-6

[2]. Gungor H, Gundogdu M, Duymus ZY. Investigation of the effect of different polishing techniques on the surface roughness of denture base and repair materials. J Prosthet Dent 2014; 112:1271-7.

[3]. Sahin O, Koroglu A, Dede DO, Yılmaz B., Influence of surface sealant agents on the surface roughness and color stability of denture base materials, J Prosthet Dent. 2016 Oct;116(4):610-616

[4]. Ucar Y, Akova T, Aysan I., Mechanical properties of polyamide versus different PMMA denture base materials, J Prosthodont. 2012 Apr;21(3):173-6

[5]. Nguyen LG, Kopperud HM, Oilo M., Water sorption and solubility of polyamide denture base materials, Acta Biomater Odontol Scand. 2017; 3(1): 47–52

[6]. Abuzar MA, Bellur S, Duong N, Kim BB, Lu P, Palfreyman N, Surendran D, Tran VT., Evaluating surface roughness of a polyamide denture base material in comparison with poly (methyl methacrylate), J Oral Sci, 2010; 52(4): 577-581

[7]. Al-Fouzan AF, Al-Mejrad LA, Albarrag AM., Adherence of Candida to complete denture surfaces in vitro: A comparison of conventional and CAD/CAM complete dentures, J Adv Prosthodont. 2017 Oct;9(5):402-408

[8]. Lazarin AA, Machado AL, Zamperini CA, Wady AF, Spolidorio DM, Vergani CE., Effect of experimental photopolymerized coatings on the hydrophobicity of a denture base acrylic resin and on Candida albicans adhesion, Arch Oral Biol. 2013 Jan;58(1):1-9

[9]. Sahin O, Dede DO, Koroglu A, Yılmaz B., Influence of surface sealant agents on the surface roughness and color stability of artificial teeth, J Prosthet Dent. 2015 Jul;114(1):130-7

[10]. Kuhar M, Funduk N., Effects of polishing techniques on the surface roughness of acrylic denture base resins, J Prosthet Dent. 2005 Jan;93(1):76-85

[11]. Radford, D.R., Challacombe, S.J., Walter, J.D., Denture plaque and adherence of Candida albicans to denture base materials in vivo and in vitro. Crit. Rev. Oral Biol. Med.1999; 10, 99–116.

[12]. Borchers L, Tavassol F, Tschernitschek H., Surface quality achieved by polishing and by varnishing of temporary crown and fixed partial denture resins. J Prosthet Dent 1999; 82:550-6.

[13]. Quirynen, M., Marechal, M., Busscher, H.J., The influence of surface-free energy and surface roughness on early plaque formation. An in vivo study in man. J. Clin. Periodont. 1990; 17, 138–144.

[14]. Sen D, Göller G, Is¸sever H. The effect of two polishing pastes on the surface roughness of bis-acryl composite and methacrylate-based resins. J Prosthet Dent 2002; 88:527-32.

[15]. Budtz-Jorgensen E., Materials and methods for cleaning dentures, J Prosthet Dent. 1979 Dec;42(6):619-23

[16]. Nicholson RJ, Stark MM, Scott HE., Calculus And stain Removal from Acrylic Resin Denture, J Prosthet Dent,1968; Volume 20, Issue 4, Pages 326–329

[17]. Al-Rifaiy MQ., The effect of mechanical and chemical polishing techniques on the surface roughness of denture base acrylic resins, Saudi Dent J. 2010 Jan; 22(1): 13–17

[18]. Oliveira LV, Mesquita MF, Henriques GE, Consani RL, Fragoso WS., Effect of polishing technique and brushing on surface roughness of acrylic resins, J Prosthodont. 2008 Jun;17(4):308-11. Epub 2007 Dec 17

[19]. Rahal, J.S., Mesquita, M.F., Henriques, G.E.P., Nobilo, M.A.A., Surface roughness of acrylic resins submitted to mechanical and chemical polishing. J. Oral Rehabil. 2004; 31, 1075–1079.

[20]. Ulusoy, M., Ulosoy, N., Aydin, A.K., 1986. An evaluating of polishing techniques on surface roughness of acrylic resins. J. Prosthet. Dent. 56, 107–112.

[21]. Craig, R.G., Powers, J.M., Wataha, J.C., 2000. Dental Materials, Properties and Manipulation, seventh ed. Mosby, St. Louis, MO.

[22]. Bollen CML, Papaioannou W, Van Eldere J, Schepers E, Quirynen M, Van Steenberghe D., The influence of abutment surface roughness on plaque accumulation and peri-implant mucositis. Clin Oral Imp Res 1996; 7:201-11.

[23]. Lou MS, Chen JC, Li CM. Surface roughness prediction technique for CNC end-milling. Journal of Industrial Technology 1998; 15:1-6.

[24]. Cucci AL, Vergani CE, Giampaolo ET, Afonso MC., Water sorption, solubility, and bond strength of two autopolymerizing acrylic resins and one heat-polymerizing acrylic resin. J Prosthet Dent 1998; 80:434-8.

[25]. Jang DE, Lee JY, Jang HS, Lee JJ, Son MK., Color stability, water sorption and cytotoxicity of thermoplastic acrylic resin for non-metal clasp denture, J Adv Prosthodont. 2015 Aug;7(4):278-87

[26]. Tuna SH, Keyf F, Gumus HO, Uzun C. The evaluation of water sorption/solubility on various acrylic resins. Eur J Dent 2008; 2:191-7

[27]. Wong DM, Cheng LY, Chow TW, Clark RK., Effect of processing method on the dimensional accuracy and water sorption of acrylic resin dentures. J Prosthet Dent 1999; 81:300-4.

[28]. Asmussen E. Factors affecting the color stability of restorative resins. Acta Odontol Scand 1983; 41:11-8

[29]. Buyukyilmaz S, Ruyter IE., Color stability of denture base polymers. Int J Prosthodont 1994; 7:372-82

[30]. Lai YL, Lui HF, Lee SY. In vitro color stability, stain resistance, and water sorption of four removable gingival flange materials. J Prosthet Dent 2003; 90:293-300

[31]. Catelan A, Suzuki TU, Becker F Jr, Briso ALF & Santos PH., Influence of surface sealing on color stability and roughness of composite submitted to ultraviolet accelerated aging, Journal of Investigative and Clinical Dentistry (2016), 1–5

[32]. Doray PG, Eldiwany MS, Powers JM., Effect of resin surface sealers on improvement of stain resistance for a composite provisional material. J Esthet Restor Dent 2003; 15: 244–50.

[33]. Soares LE, Cesar IC, Santos CG et al. Influence of coffee on reflectance and chemistry of resin composite protected by surface sealant. Am J Dent 2007; 20: 299–304.

[34]. Braun, K.O., Mello, J., Rached, R.N., Del Bel Cury, A.A., Surface texture and some properties of acrylic resin submitted to chemical polishing. J. Oral Rehabil. 2003;30: 91–98

[35]. Perez Cdos R, Hirata RJ, da Silva AH, Sampaio EM, de Miranda MS. Effect of a glaze/composite sealant on the 3- D surface roughness of esthetic restorative materials. Oper Dent 2009;34: 674–80

[36]. Dede DO, Sahin O, Koroglu A, Yilmaz B, Effect of sealant agents on the color stability and surface roughness of nanohybrid composite resins, J Prosthet Dent. 2016 Jul;116(1):119-28

[37]. Joniot S, Salomon JP, Dejou J, Gregoire G. Use of two surface analyzers to evaluate the surface roughness of four esthetic restorative materials after polishing. Oper Dent 2006; 31: 39–46
[38]. Bhushan B,Wyant JC, Koliopoulos CL., Measurement of surface topography, surface roughness analysis and measurement technique
[39]. Santos M, Soo S, Petridis H., The effect of Parylene coating on the surface roughness of PMMA after brushing, J Dent. 2013 Sep;41(9):802-8
[40]. Jones CS, Billington RW, Pearson GJ., The in vivo perception of roughness of restorations, Br Dent J. 2004 Jan 10;196(1):42-5

Samin HS, Jayakrishna Kumar S, Ramakrishnan H "Comparative Evaluation of the Effect of the Tooth Brushing On the Surface Roughness and Colour Stability of Poly (Methyl Methacrylate) Heat Cure Resin with Application of Denture Sealant." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 18, no. 10, 2019, pp 44-54.