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IMPACT OF TEMPERATURE CHANGE ON COLOR STABILITY OF PROVISIONAL FIXED PARTIAL DENTURE MATERIAL AFTER IMMERSION IN STAINING SOLUTIONS

[1*]Dr. Navneet Sran, [2]Dr. Reena Mittal, [3]Dr. Swatantra Agarwal, [4]Dr. Riya Gugale, [5]Dr. Jagjot Singh Saluja, [6]Dr. Karan Kumar Gupta

India.

***Corresponding Author: Dr. Navneet Sran**

India.

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ABSTRACT

Background: A provisional restoration is an integral part of successful treatment for fixed prosthesis while the final prosthesis is being fabricated as they provide pulpal protection, maintain periodontal health, occlusal relationship and also help in deciding the shade, shape and contour of the final restoration. Color stability is one of the important properties of these materials. Regardless of composition and polymerization method, these materials tend to undergo color changes and roughness over time. Thus, the purpose of the study is to analyse the impact of temperature change on colour stability of provisional fixed partial denture material after immersion in staining solutions (tea). **Methods:** Specimens (n=20) with diameter of 20±1mm and 3mm thickness were fabricated from polymethyl methacrylate auto-polymerized resin. Initial color evaluation using CIE L*a*b* system was done by Spectrophotometer and baseline readings were recorded. After baseline readings, staining solutions (tea and synthetic saliva) with their respective temperatures (37^0C and 57^0C) were prepared and samples were immersed for 2 weeks. Final color evaluation was done again with the help of spectrophotometer. **Results:** The highest influence on ΔE was exerted by synthetic saliva + tea at 57 ºC followedby synthetic saliva + tea at 37 ºC, synthetic saliva at 57 ºC and synthetic saliva at 37 ºC. **Conclusion:** The degree of discoloration of the materials depends on food and temperature. Higher the temperature, more is the discoloration.

KEYWORDS: Provisional restorations, color stability, staining solutions, spectrophotometry.

INTRODUCTION

A provisional restoration is an integral part of successful treatment for fixed prosthesis as theyprotect the prepared abutment teeth, while the final prosthesis is being fabricated. They provide pulpal protection, maintain periodontal health, occlusal relationship and tooth position of the abutment tooth and also help in deciding the shade, shape and contour of the final restoration.[1] It may also be used to determine the esthetic, functional and therapeutic effectiveness of a treatment plan. Provisional crowns and fixed partial dentures are typically fabricated from one of many available methacrylate or bis-acryl resins, each having slightly different proprietary chemistry and properties.[2]

Discoloration of provisional restorations can be an esthetic problem, especially when the treatment plan requires long-term provisionalization. It may be the result of several extrinsic (exogenous) or intrinsic (endogenous) factors.[3] Intrinsic discolorations are irreversible while the extrinsic discolorations are caused by adsorption of dyes or plaque and can be easily removed by polishing.[4] Exogenic factors can be the material's surface properties, water absorption, dietary composition and oral hygiene, whereas endogenic factors represent the polymer composition of matrix and fillers as well as polymerization time.[5]

Water sorption or water absorption shows high dependence on solution temperature, so water sorption consistently increases as the solution temperature increases.[6] There is little information in the current literature on the impact of temperature of staining solutions on provisional restorative material's discoloration. It could be conceivable that an elevated temperature (57°C versus 37°C) accelerates staining and discoloration.[5] Thus, the purpose of the study is to analyse the impact of temperature change on colour stability of provisional fixedpartial denture material after immersion in staining solutions (tea). The null hypothesis for the present study is that there is no effect of temperature change on the color stability of provisional fixed partial denture material after immersion in staining solutions.

METHOD

A total of 20 disc-shaped specimens with diameter of 20±1mm and 3mm thickness were fabricated from polymethyl methacrylate auto-polymerized resin (Tempron). Specimens were fabricated using a PVC pipe with an inner diameter of 20mm. Cylindrical molds with thicknessof 3mm were cut from the pipe with the help of a saw. These molds were placed on glass slab and material was loaded in the mold. Another glass slab was placed over the molds to attain specific dimension. Finishing of the samples was done on both sides with abrasive papers. Initial color evaluation using CIE L*a*b* system was done by Spectrophotometer and baselinereadings were recorded. After baseline readings, staining solutions with their respectivetemperatures were prepared (tea and synthetic saliva). Twenty samples were equally divided into 4 subgroups having 5 samples each according to staining solutions and their different temperatures and were immersed in the solutions for ten min a day for about two weeks.

Subgroup 1: Five samples of Polymethyl methacrylate immersed in synthetic saliva at 37^0C.

Subgroup 2: Five samples of Polymethyl methacrylate immersed in synthetic saliva at 57^0C.

Subgroup 3: Five samples of Polymethyl methacrylate immersed in synthetic saliva and tea at37^0C.

Subgroup 4: Five samples of Polymethyl methacrylate immersed in synthetic saliva and tea at57^0C.

Immersion of Samples

Five samples of provisional restorative material were immersed in solution 1 (synthetic saliva) for 10 minutes once a day at 57^0C. After immersion for 10 minutes, they were removed from the solution, rinsed thoroughly and immersed in synthetic saliva at 37^0C (control) for rest of the day. Both these temperatures were maintained using an incubator.

Similarly, five samples of provisional material were immersed in solution 2 (synthetic saliva and tea) for 10 minutes twice a day (morning and evening) at 57^0C. After immersion for 10 minutes, samples were removed from the solutions, rinsed thoroughly and immersed in synthetic saliva at 37^0C (control) to simulate the oral environmental conditions.

Similarly, five samples of provisional material were immersed in solution 2 (synthetic saliva and tea) for 10 minutes twice a day (morning and evening) at 37^0C. After immersion for 10 minutes, samples were removed from the solutions, rinsed thoroughly and immersed in synthetic saliva at 37^0C (control) to simulate the oral environmental conditions.

Synthetic saliva at 37^0C was used as control and contained five samples for whole day.

All these solutions were changed after every 24 hours and this process was repeated every day for 2 weeks. After two weeks, final color evaluation was done again with the help ofspectrophotometer.

RESULTS

Results obtained were statistically analysed using SPSS (Statistical Product and Service Solution) Version 16 for Window (SPSS Inc, Chicago, IL).

Table 1: Descriptive statistics of colour change (ΔE*) of provisional fixed partial denture material after immersion in staining solutions at different temperatures.

S. No	Sub-group 1 (Synthetic salivaat 37º C)[Control]	Sub-group 2(Synthetic salivaat 57º C)	Sub-group 3 (Synthetic saliva +Tea at 37º C)	Sub-group 4 (Synthetic saliva + Tea at 57º C)
1	0.07	0.014	4.44	5.86
2	0.05	0.066	4.21	6
3	0.08	0.103	4.2	6.25
4	0.16	0.087	5.21	6.03
5	0.1	0.061	3.63	5.94
Mean	0.0920	0.0662	4.33	6.01
SD	0.04	0.03	0.57	0.14
SE	0.018	0.015	0.25	0.06
Minimum	0.05	0.01	3.63	5.86
Maximum	0.16	0.1	5.21	6.25

Table 2: Intra-group comparison of colour change (ΔE*) of Polymethyl methacrylate after immersion in staining solutions at different temperatures.

Sub-group	Mean	S.D	One way Anova 'F'test	P value, Significance
Sub-group 1 (Synthetic saliva at37º C)	0.09	0.04	F = 520.20	p <0.001**
Sub-group 2 (Synthetic saliva at57º C)	0.06	0.03		
Sub-group 3 (Synthetic saliva +tea at 37º C)	4.33	0.57		
Sub-group 4 (Synthetic saliva +tea at 57º C)	6.01	0.14		

*p<0.05 – significant difference **p<0.001 – highly significant difference

Table 3: Tukey's post hoc test to find pairwise comparison among staining solutions atdifferent temperatures in samples of Polymethyl methacrylate.

Group	Comparison Group	Mean Difference	p value,Significance
Subgroup 1 (Synthetic saliva at 37º C)	Group 2 (S.S at 57º C)	0.025	p = 0.999
	Group 3 (S.S + tea at 37º C)	4.24	p <0.001**
	Group 4 (S.S + tea at 57º C)	5.92	p <0.001**
Subgroup 2 (Synthetic saliva at 57º C)	Group 3 (S.S + tea at 37º C)	4.27	p <0.001**
	Group 4 (S.S + tea at 57º C)	5.94	p <0.001**
Group 3 (Synthetic saliva + tea at37º C)	Group 4 (S.S + tea at 57º C)	1.67	p <0.001**

*p<0.05 – significant difference **p<0.001 – highly significant difference

DISCUSSION

Based on the results of the study, the null hypothesis i.e., there is no effect of temperature change on the color stability of provisional fixed partial denture material after immersion in staining solutions was rejected. Statistically significant differences were found among the color stability of provisional materials at different temperatures of the staining solutions.

From the results of the present study, it was revealed that tea caused discoloration in both the temperatures. Among the staining solutions, maximum discoloration was seen in synthetic saliva + tea at 57ºC followed by synthetic saliva + tea at 37ºC, synthetic saliva at 37ºC and minimum in synthetic saliva at 57º C. These results were agreement to the studies done by Liebermann et al.[5] and Kim et al.[6]

Discoloration by tea might be due to both surface adsorption and absorption of colorants. Teaparticles may have deposited into the pits of the polymethyl methacrylate. The pits may have formed due to the polymerization shrinkage of the resin. The less polar colorants and water- soluble polyphenols in tea, for example, tannin, might have penetrated deep into the materials.[9]

Tea leaves contain a considerable amount of flavonoid and methylxanthine compounds, which gives tea its functional properties and flavour. However, teaflavins in tea leaves are reported tobe the cause of discoloration.[10]

Regardless of the resin products, water sorption significantly and consistently increases as the solution temperature increases, which may be partly due to the expansion of the specimen. As the specimen expands, water uptake through the interface and internal defects increases by the increased area of these interface or defects.[6]

Higher temperature lead to more severe discoloration of provisional materials. This could be explained by the fact that polymer networks generally tend to absorb water which can lead not only to mechanical weakening, but also to higher discoloration rates with an esthetically compromised outcome through accumulation of various food colorants in the deeper material surface. Discoloration is strongly related to the composition of the polymers, since water absorption takes place exclusively in the matrix of the polymers, especially at the OH- groups. With the increased water intake, the deposits of the molecules of tea influences the ΔE values. These results could be different under extended storage and should be investigated in further studies.[5]

There are certain limitations of the present study. Since the present study is an invitro study, intra oral conditions like different temperatures of oral fluids and saliva was not simulated in laboratory conditions. Moreover, the present study utilized only a specific shape of samples and that the complex shapes like provisional fixed partial dentures were not used.

Therefore, more studies should be conducted on color stability of provisional fixed partial denture materials under varying temperature conditions as there are limited number of studieson the impact of temperature change.

The clinical implication of the results of the present study is that esthetic demands for color stability of provisional prosthodontic materials in a clinical setting are essential considerations. Drinking practices of the patient must be measured while selecting the type of provisional crown and bridge resin, particularly in the aesthetic zone. Since color stability of provisional materials is an essential consideration, it can be maintained for longer time period by some restrictions on dietary habits.[11]

CONCLUSION

From the present study, it can be stated that the degree of discoloration of provisionalrestorative materials depends upon commonly consumed food beverages and temperature of the solution. Higher the temperature, more is the discoloration. Therefore, patient should be counselled about certain beverages which can deleteriously affect the properties of provisionalmaterials. Dietary restrictions should be imposed on patient on consumption of hot beverages till the time of provisionalization.[11]

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