



Colour Stability of Orthodontic Esthetic Elastomeric Ligatures - An in Vivo Study

Authors

**Dr Kalyani Shriniwas Chatla¹, Dr Sunilkumar Pulluri², Dr Srinivas Ambarkar³,
Dr Akash Lavate⁴, Dr Sneha Hoshing⁵, Dr Sneha Shinde⁶, Dr Neha Deshmukh⁷**

^{1,7}Postgraduate Student, Department of Orthodontics and Dentofacial Orthopedics, Pandit Deendayal Upadhyay Dental College, Kegaon, Solapur

²MDS, Head of Department (Orthodontics and Dentofacial Orthopedics), Pandit Deendayal Upadhyay Dental, College, Kegaon, Solapur

³MDS, Professor, Department of Orthodontics and Dentofacial Orthopedics, Pandit Deendayal Upadhyay, Dental College, Kegaon, Solapur

^{4,5}MDS, Reader, Department of Orthodontics and Dentofacial Orthopedics, Pandit Deendayal Upadhyay Dental College, Kegaon, Solapur

⁶MDS, Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Pandit Deendayal Upadhyay Dental College, Kegaon, Solapur

Introduction

Esthetic brackets have become quite popular in Orthodontics in recent decades due to their excellent color stability and adherence. Furthermore, the demand for orthodontic treatment with aesthetic orthodontic brackets among adult patients has increased significantly. Also, clinical orthodontists are concerned about the elastomeric ligatures used to connect the bracket/wire combination and want to ensure that the ligatures' properties stay intact. Color changes caused by staining resulting from food ingestion or contact with intraoral fluids are particularly undesirable. These changes are due to swelling and discoloration when elastomers are exposed to the intraoral environment, and it is caused by buccal fluids and bacteria that fill up the spaces in the rubber matrix⁽¹⁾⁽²⁾. To minimize the influence of some types of food affecting the color of elastomeric ligatures, metallic pigments have been

added during the manufacturing process; however, they reduce the level of force released, impairing their elastomeric properties⁽¹⁾.

Much research has been conducted to investigate the impact of the oral cavity on the elastic characteristics of elastomeric ligatures, such as force decay, friction, and dimensional changes.⁽³⁾⁽⁴⁾⁽⁵⁾ Researchers, on the other hand, have shown minimal concern regarding the behavior of orthodontic materials following exposure to the oral environment, particularly the extent to which these changes interfere with aesthetics. Color changes in the elastomeric modules used to connect orthodontic archwires to brackets are a common concern among orthodontists and patients.

In vitro studies have shown that esthetic elastomers become stained after being immersed in liquids with high susceptibility to pigmentation⁽⁶⁾⁽⁷⁾⁽⁸⁾⁽⁹⁾. However, these studies were

conducted in vitro, which may not reflect the numerous factors present in the intraoral environment contributing to color change, such as the oral flora, temperature variation, the mechanical effect of brushing, and solid and semi-solid food that cause pigmentation. Thus, clinical investigations can provide a more accurate study of actual color changes that occur in orthodontic material following clinical usage.⁽¹⁰⁾ Thus, this study aimed to evaluate in vivocolor stability of orthodontic esthetic elastomeric ligatures from four different manufacturers.

Material and Methods

This study evaluated four brands of esthetic orthodontic elastomeric ligatures: Metro, Modern, JJ orthodontics, and Orthomatrix (Figure 01). A split-mouth, prospective study was designed. The elastomeric modules were used in 20 adult patients undergoing orthodontic treatment in the Department of Orthodontics. In each patient, the four brands were distributed by hemiarch and remained in the oral environment for 30 days.

The scoring process of elastomeric modules was performed while patients were using the ligatures. The ligatures were scored on the same day they were placed (T0), and after 30 days of exposure in the intraoral environment (T1). Evaluation of esthetic elastomeric modules was carried out visually and under cold light, by the examiner in T0 and T1, under the same light conditions. There was no advice given to any of the patients on dietary restrictions. The analysis involved the use of scores according to the degree of staining,⁽¹⁰⁾ in which: 0 = nonpigmented ligatures; 1 = slightly pigmented; 2 = moderately pigmented, and 3 = heavily pigmented. (Figure 03)

Statistical Analysis

One-way ANOVA 'F' test was applied to compare the mean in different brands of esthetic elastomeric ligatures. Pair wise multiple comparisons between all brands were assessed using the Post hoc Tukey HSD test. A p-value less than 0.05 was considered significant.

Results

An analysis of the elastomeric ligatures before insertion in the mouth yielded a zero (0) score for all specimens examined. The mean difference of all four brands at T1 was analysed using the ANOVA test which stated that the Orthomatrix aesthetic elastomeric ligature showed statistically less pigmentation and Modern orthodontics showed significantly more pigmentation.

Comparison between brands was done using Tukey's Post-hoc test. It revealed that when Orthomatrix was compared with Modern and JJ orthodontics showed statistically higher significance whereas when compared with Metro did not show any significance. (Table 2)

When Modern elastomeric ligatures were compared with Orthomatrix and Metro elastomeric ligatures, they showed statistically significant results whereas when compared with JJ orthodontics did not show any significance. (Table 2)

When JJ orthodontic elastomeric ligatures were compared with Orthomatrix and Modern showed statistically significant results whereas when compared with Modern orthodontics did not show any significance. (Table 2)

When Metro orthodontic elastomeric ligatures were compared with JJ and Modern showed statistically significant results whereas when compared with Orthomatrix orthodontics did not show any significance. (Table 2)

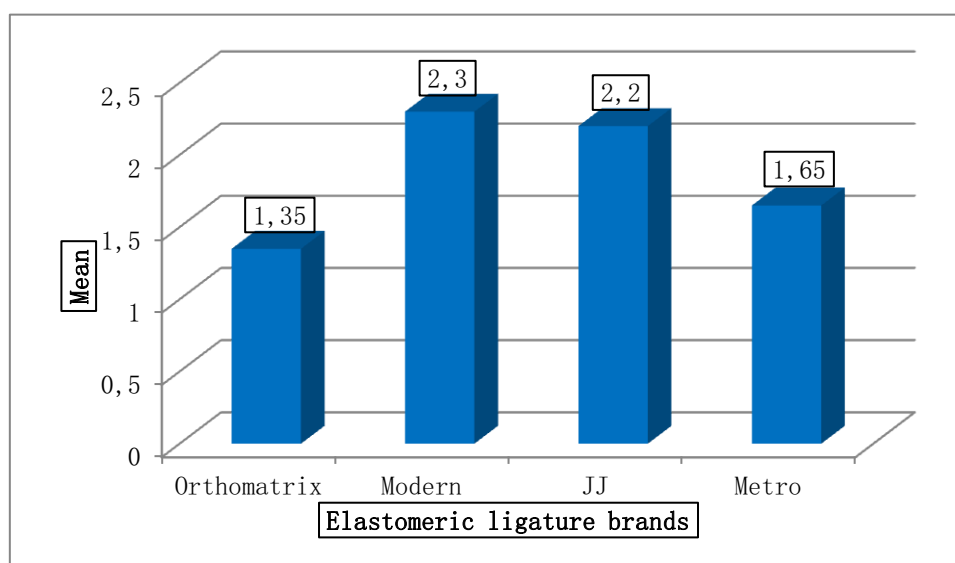
Table 1: Difference between the four groups at T1 using one way ANOVA test

Groups	Mean	Standard deviation	95% Confidence Interval for mean		F	p
			Lower	Upper		
Orthomat	1.3500	.48936	1.1210	1.5790	18.808	.000
Modern	2.3000	.47016	2.0800	2.5200		
JJ	2.2000	.41039	2.0079	2.3921		
Metro	1.6500	.48936	1.4210	1.8790		

Table 02: Pairwise Multiple comparisons for table 1 using Tukey’s Post-hoc test

Groups		Mean Difference	p	95% Confidence Interval for the mean difference	
				Lower	Upper
Orthomat	Modern	-.95000	.000*	-1.3370	-.5630
	JJ	-.85000	.000*	-1.2370	-.4630
	Metro	-.30000	.184	-.6870	.0870
Modern	Orthomat	.95000	.000*	.5630	1.3370
	JJ	.10000	.905	-.2870	.4870
	Metro	.65000	.000*	.2630	1.0370
JJ	Orthomat	.85000	.000*	.4630	1.2370
	Modern	-.10000	.905	-.4870	.2870
	Metro	.55000	.002*	.1630	.9370
Metro	Orthomat	.30000	.184	-.0870	.6870
	Modern	-.65000	.000*	-1.0370	-.2630
	JJ	-.55000	.002*	-.9370	-.1630

Graph: Graphical presentation of mean difference using ANOVA test in all four brands



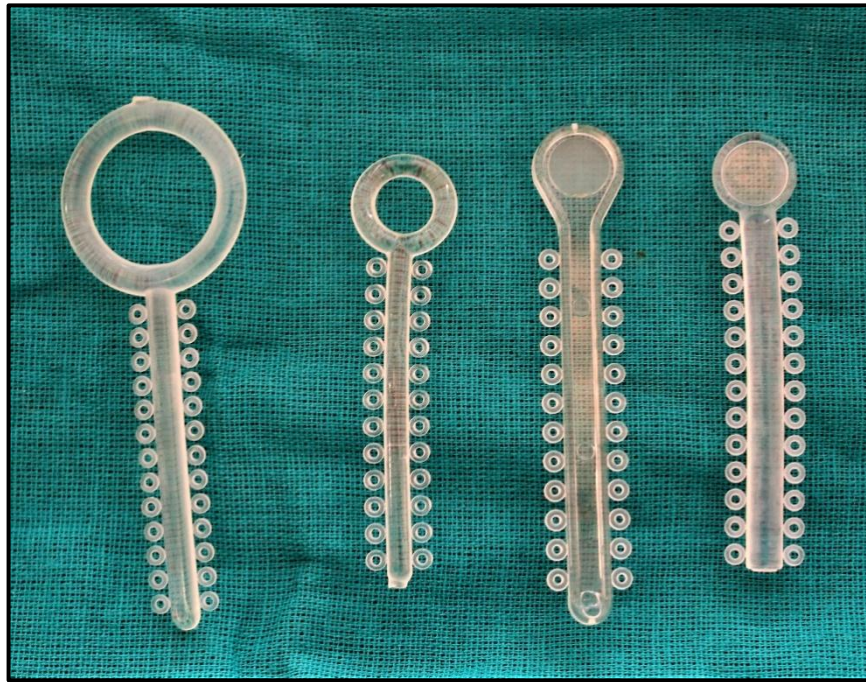


Fig 01: Different brands used for the study.

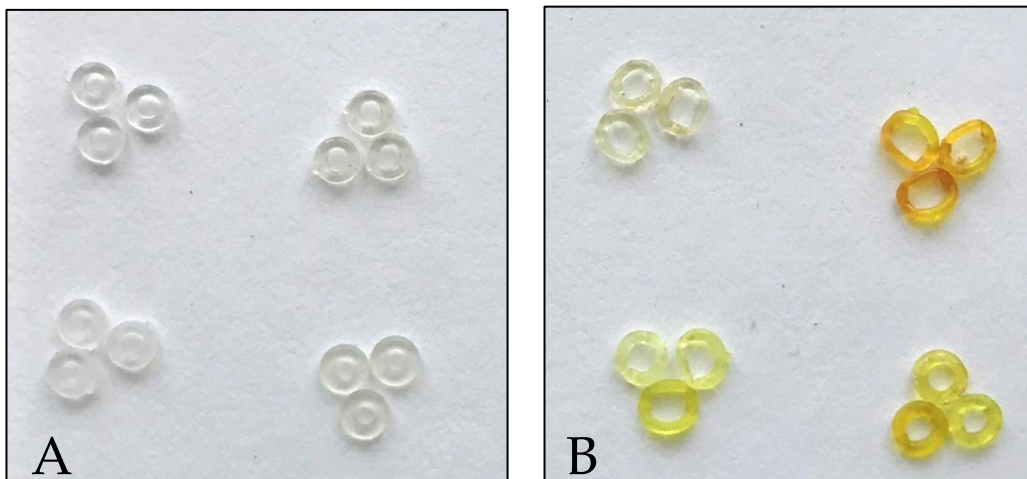


Fig 02: A: Before placement, B: After 30 days exposure in the mouth.

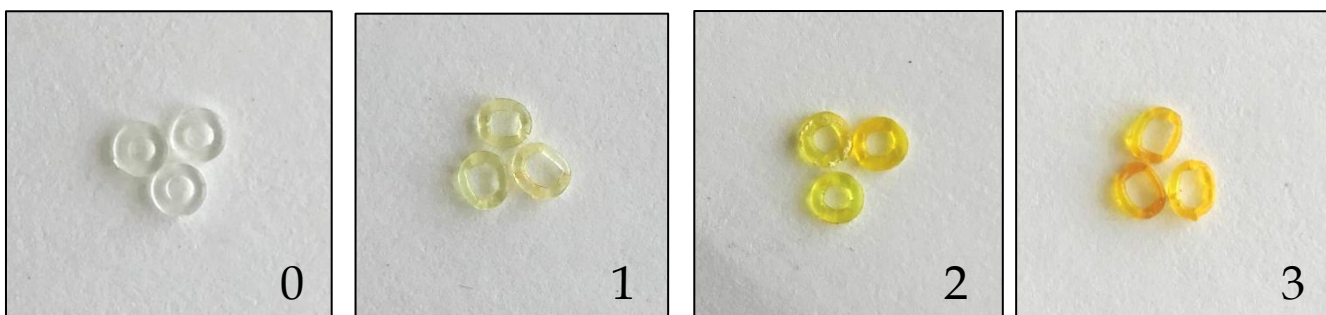


Fig 03: 0) No pigmentation, 1) Slightly pigmented, 2) Moderately pigmented, 3) Heavily pigmented.

Discussion

Patients' issues about facial esthetics and properly aligned teeth, together with improved life expectancy and quality of life, have raised the need for orthodontic treatment in adult patients, and therefore the demand for esthetic orthodontic products. Despite significant advancements in the quality and stability of bracket color, esthetic appliances face the difficulty of variations in the color of esthetic orthodontic ligatures when exposed to the intraoral environment. As a result, patients' complaints are common, when the entire bracket/ligature combination becomes less attractive as elastomers stain.

Changes in the color of orthodontic ligatures have been performed by in vitro laboratory studies,⁽⁶⁾⁽⁷⁾⁽⁸⁾ whereas the literature reports few in vivo analyses of such color changes. This study, therefore, provides results that are closer to reality by assessing color changes in elastomeric ligatures after exposure to the oral environment. Assessments of the physical properties of elastomeric ligatures have reported significant changes in the structure and composition of these materials after exposure to the oral environment⁽³⁾⁽⁵⁾⁽¹⁰⁾.

Variations in the friction force of elastomeric ligatures of different brands were observed after immersion in laboratory solutions in an attempt to reproduce the oral environment⁽¹¹⁾. After exposure to the oral environment for 3 weeks and subsequent analysis by optical microscopy and spectroscopy, the elastomeric ligatures exhibited precipitates of calcium and phosphorus with the formation of calcium phosphate on the surface. A significant change was found in the structure and composition of the surface of the elastomeric ligatures after exposure to the oral environment, indicative of the severity of changes that can occur in the properties of these materials⁽¹²⁾.

This clinical study differs from a Silva et al investigation⁽¹⁰⁾ whereby analysis of elastomer pigmentation was carried out outside the intraoral

environment. The ligatures were removed, photographed, and then analyzed, which could differ in the results, depending on the calibration when capturing the images. Because various brands are investigated by a direct visual study in the intraoral cavity, in vivo assessments of staining in aesthetic orthodontic ligatures might produce more accurate results.

On direct visual analysis of esthetic elastomeric ligatures, in this present study four brands were used namely: Modern, Metro, JJ, and Orthomatrix. Orthomatrix showed least pigmented which showed statistically significant and Modern showed statistically highly pigmented. When Orthomatrix compared with metro did not show any statistical significance and when modern compared with JJ did not show any statistical significance.

Dental material science has focused on the properties of as-received material rather than on changes produced after intraoral exposure⁽¹³⁾⁽¹⁴⁾.

The findings of this study support increased investment in research and technology to improve the color stability of aesthetic orthodontic ligatures. For the time being, aesthetic self-ligating brackets, which eliminate the need for elastomeric ligatures, are a viable clinical option. Despite the elimination of unwanted staining in ligatures, metal clips, which are commonly used in these attachments, contribute to a significant loss in appliance aesthetics. Another option for the clinician, which is less expensive than aesthetic brackets, is to tie the wire/bracket combination with aesthetic steel ligatures. The main disadvantage of this method is that it requires more chair time than self-ligating brackets.

Limitations of the Study

- The data collected for the study is limited to the convenience of researchers, results would be good if the data has been collected from a wide group of patients.

- The degree of staining is done on visual analysis, its interpretation may differ from person to person.

Future Scope of the Study

- Evaluation of color stability of clear elastomeric ligatures was done on four different brands, in the future other than these brands could be evaluated.
- Patients who are concerned esthetically should prescribe superior clear elastic ligatures.
- In the future addition to color stability, physical properties and plaque accumulation should be evaluated in further studies.

Conclusions

- The color of esthetic elastomeric modules of all four brands used in the study changed after exposure to the oral environment.
- Orthomatrix and Metro clear elastomeric modules are less pigmented after 30 days of exposure in the oral environment.
- Modern and JJ clear elastomeric modules are more pigmented after 30 days of exposure in the oral environment.

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