Colour Stability and Fluorescence of Different Esthetic Orthodontic Archwires

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ABSTRACT

Objective: To evaluate the colour stability of four esthetic archwires at different time periods and their fluorescence. **Materials and Methods:** Samples of the four brands (LIBRAL, CLASSIC, JJ ORTHODONTICS and ORMCO) were evaluated after 7 days and 14 days of immersion in staining solution. Colour measurements were performed by means of a spectrophotometer and colour changes were computed. The fluorescence of as- received samples was evaluated by two observers and compared with that of a human central incisor. Using analysis of variance and Tukeys post-hoc test different statistical parameters were investigated. **Results:** All brands showed statistically significant colour change after 14 days. The Rabbit force archwires by LIBRAL presented the highest colour alteration. The OPAL archwires by CLASSIC presented with the least colour change. All the four archwires showed low fluorescence when compared to that of a human central incisor. **Conclusion:** Clinically noticeable colour change was seen in the esthetic archwires that were assessed after placing them in staining solution for 14 days.
KEYWORDS: Colour Stability, Fluorescence, Esthetic Archwires

INTRODUCTION

Due to the increasing demand for esthetic orthodontic appliances, development of materials with acceptable esthetics for patients and adequate clinical performance for clinicians is needed as appearance is the prime concern of patients during orthodontic treatment.[1] Esthetics of various orthodontic appliances has improved significantly with the use of the latest esthetic transparent brackets made of ceramics or composites. Later metallic archwires coated with Teflon or epoxy resin were introduced, which are formed by the atomised Teflon particles being coated by using clean compressed air as a transport medium, which is further heat treated in a chamber furnace. The epoxy coating is manufactured with a depository process that plates the base wire with an epoxy resin of approximately 0.002 inches in thickness.[2]

Many problems have been identified with these esthetic archwires such as the lack of translucency and the transparency of an archwire, wearing or peeling off of the outer coating and the limited bending of the wire. The outer layers should have optimal properties since they are biomechanically the most important owing to their distance from the neutral axis.[3]

The present study was done to evaluate the colour stability of four esthetic archwires at different time periods and their fluorescence.

MATERIALS AND METHODS

In this study, four brands of esthetic archwires were assessed. The brands, cross – section size, composition,

and coating surfaces are shown in table 1, as described by the companies.

Wire name and manufacturer	Cross section size	Composition	Coating surface
Rabbit force – LIBRAL	16x22	Niti	All surfaces
Opal – CLASSIC	0.18	Niti	All surfaces
Prime Ortho - Ormco	17x25	Niti	All surfaces
JJ Orthodontics	16x22	Niti	All surfaces

Table 1

Five samples of each brand were prepared. Each sample was made by placing a 10mm long wire segments together and uniting their juxtaposed ends with ethyl cyano acrylate. The esthetic coating surface of every wire segment was facing the same direction, and the total width of each sample had to be at least 7mm so that its colour can be properly measured. Samples were evaluated after 7 and 14 days of immersion in staining solution. Color measurements were performed by means of a spectrophotometer. The fluorescence of the as received samples is evaluated by two observers and compared with that of a human central incisor.

Preparation of staining solution: The staining solution was prepared by pouring 500ml of boiled distilled water over 15gms of coffee powder. The stirring of solution was done every 30 minutes for 10 seconds until the temperature falls to 37°C and then filtered through a filter paper. This liquid mixture was then poured into a test

tube and covered with a sterile cotton swab and was kept in an incubator at 37°C during the entire experiment. To reduce the precipitation of particles, the mixture was stirred once a day for 1 minute.

Colour observations: The specimens were stored in distilled water at 37°C for 24 hours before immersed into the solution. After 24 hours of immersion (T0), the colour of each sample was observed using the spectro-photometer. After (T0), the samples were placed in a test tube with the prepared staining coffee solution and colour measurements were repeated after 7 days (T1), 14 days (T2) respectively.

Before each measurement, samples were cleaned and dried from the solution by rinsing with distilled water in an ultrasonic cleaning bath for 5 minutes and excess water on the surfaces was removed with tissue papers.

Before starting the process, the spectrophotometer was calibrated according to the instructions given by the manufacturers. Five measurements of each brand with five samples each were taken. The average value of each sample with these five readings was recorded. According to Konova et al. the absorbance range for polytetrafluoroethylene is at 350nm, 400nm, and 450nm and the maximum absorbance is at 350nm.[4] Measurements were made at these wavelengths. Total colour differences were expressed by the formula:[5]

$$\Delta E^* = ([\Delta L^*]^2 + [\Delta a^*]^2)^{\frac{1}{2}}$$

ΔL^* and Δa^* are differences in L^* and a^* before (T_o) and after immersion at (T_1, T_2).

Koksal and Dikbas related the amount of colour change (ΔE^*) to clinical environment by converting it into National Bureau of standards (NBS) units as follows:[6]

NBS Units = = $\Delta E^* \times 0.92$

Nbs Units		Definitions Of Colour Differences
0.0-0.5	Trace	Extremely Slight Change
0.5-1.5	Slight	Slight Change
1.5-3.0	Noticeable	Perceivable Change
3.0-6.0	Appreciable	Marked Change
6.0-12.0	Much	Extremely Marked Change
12.0+	Very Much	Change To Other Colour

Table 2: Critical marks of colour change according to National Bureau of Standards

Fluorescence Assessment: The samples were randomly arranged in a dark room which is devoid of natural light but with a fluorescent black lamp placed 30cm above the samples to observe the fluorescence and each sample was placed on the labial surface of human incisor crown. Samples were classified independently according to fluorescence levels as high, medium and low.

Statistical analysis: The described formula helps us to calculate the ΔE^* values and also the descriptive statistical analyses were applied to each group at all times, and Tukey's post hoc test and the analysis of variance were used to verify differences in colour between groups and between time periods. Values were designated as statistically significant at $P < 0.05$.
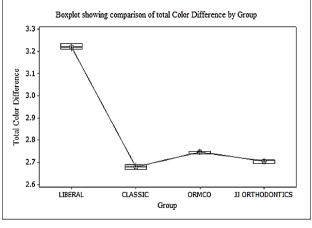
RESULTS

To relate the amount of color change (ΔE^*) recorded by the spectrophotometer to the clinical environment, the data was converted into NBS units.

Group	Mean	SD	F-Value	P-Value	Decision
LIBRAL	3.2213	.01520	2580.533	0.000	Significant
CLASSIC	2.6794	.01127			
ORMCO	2.7471	.00737			
JJ ORTHO-DONTICS	2.7059	.00993			

Table 3: Mean and Standard Deviation Of the total colour difference for the four study groups

This table shows that the average value of Classic total color difference was significantly lower than the remaining three groups followed by JJ Orthodontics and ORMCO and then Libral at 5% level of significance as per the significant P-value (0.000) of the ANOVA test (2580.533) mentioned above. The same was mentioned below as a box plot with a circled plus which indicates the average value, the lower end and upper end of the box reveals the 25th and 75th percentile respectively, the lower end and upper end of the line specifies the lower and upper value respectively.

Graph 1

To know the significant mean colour difference among the study groups Post Hoc Tukey's (HSD) Comparison test was conducted. (Table 4)

Multiple Comparisons

Dependent Variable: Total Color Difference
Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Sig.
LIBERAL	CLASSIC	.54191*	.000
	ORMCO	.47417*	.000
	JJ ORTHODONTICS	.51535*	.000
CLASSIC	LIBERAL	-.54191*	.000
	ORMCO	-.06775*	.000
	JJ ORTHODONTICS	-.02656*	.009
ORMCO	LIBERAL	-.47417*	.000
	CLASSIC	.06775*	.000
	JJ ORTHODONTICS	.04119*	.000
JJ ORTHODONTICS	LIBERAL	-.51535*	.000
	CLASSIC	.02656*	.009
	ORMCO	-.04119*	.000

*. The mean difference is significant at the .05 level.

Table 4: Post Hoc Tukey Multiple Comparision Test

DISCUSSION

Not only colour differences that are initially observed between the different existing esthetic archwires but also the color stability of coated archwires during orthodontic treatment is also important. In this present study, the color stability of these archwires could be reliably evaluated.

Ideally, the colour of esthetic archwires should match that of natural teeth and esthetic brackets. Still, a lot of experiments are being conducted on the fiber – reinforced archwires on their properties like friction and durability. Coated metallic archwires are currently the best option for clinical use.[7]

Generally, values in the range of one unit are considered exact colour matches because they cannot be identified by independent observers. The subjective interpretation of visual colour comparison eliminated by instrumental measurements, spectrophotometers are used instead of visual evaluation.[8]

Colour changes are characterised using the CIE L*a*b* colour space.[5] The CIE L*a*b* colour space is currently one of the most popular and widely used systems of colour measurement, and it is well suited for the determination of small colour differences.

Stober et al. Eliades et al. have used ΔE^* values to evaluate the perceptibility of color differences. However, it is noteworthy that the criteria of perceptibility adopted by each author were different. To counter such differences and disagreements in the criteria used, the NBS rating system is frequently used to determine the degree of colour differences, as it offers absolute criteria by which ΔE^* values can be converted to definitions with clinical significance.[9,10]

Studies by, Mutlu – Sogesen and Ertas et al. have concluded that coffee was the most chromogenic agent in comparison with other staining substances, such as tea and cola drinks. For this reason, a coffee solution was used in this study to evaluate the effect of staining.[11, 12]

In the present study, colour changes of Classic, Ormco, and JJ archwires intensified with a longer immersion period. This finding was due to the change in optical properties within a polymer which could be responsible for the colour changes seen clinically.[13]The chemical discoloration may be caused by the oxidation of unreacted double bonds in the matrix polymer and subsequent formation of degradation products from the water diffusion or oxidation of polymer. This can explain the staining behaviour of coated archwires over time. LIBRAL did not show much difference between the two time periods. After the two week immersion period all wires showed noticeable colour change according to NBS units.

CONCLUSION

- All esthetic archwires showed noticeable colour change after 14 days.
- The rabbit force archwires by LIBRAL showed the most pronounced colour alteration.
- The opal archwires by classic showed less colour change.
- All the archwires showed low fluorescence.

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