REVIEW ARTICLE

Esthetic orthodontic archwires: Literature review

Sertac Aksakalli, Siddik Malkoc[1]

[1]Department of Orthodontics, Bezmialem University, Faculty of Dentistry, Istanbul, [2]Department of Orthodontics, Inonu University, Faculty of Dentistry, Malatya, Turkey

ABSTRACT

There is a growing request for esthetic orthodontic appliances and by the effect of this request, most of the companies produced new esthetic appliances. These new appliances combine both acceptable esthetics and adequate technical performance. Recently, coated metallic and fiber-reinforced wires have beenintroduced to solve esthetic appearance problem. In the literature, there are some studies mostly researching on mechanical, color, and roughness properties. They are clinically acceptable but so many properties must be studied and must be developed for better results.

Key words: Aesthetics, coating, wire

Introduction

There is a growing demand for esthetic orthodontic appliances. This demand has led to the development of orthodontic appliances with acceptable esthetics both for patients and clinicians. In orthodontics, there are more esthetic brackets and archwires in the market when compared to mid-1990s.

Most of the orthodontic appliances are metallic and silver in color and at the beginning esthetic production, there were transparent brackets made of ceramic or composite. But the archwires are still made of metals such as titanium molybdenum alloy, nickel titanium, or stainless steel. Recently, coated metallic and fiber-reinforced wires have beenintroduced to solve esthetic appearance problem.[1] Fiber-reinforced wires are experimental and not universally commercial available, there are good expectations from them for the future.[2] Coated esthetic wires are the only esthetic archwire available for usage.

Access this article online	
Quick Response Code:	Website: www.jorthodr.org
	DOI: 10.4103/2321-3825.112246

Materials used for coating are plastic resins such as epoxy resin or synthetic resin. The coating is manufactured with a depository process which plates the base wire with approximately 0.002 thickness.[3] Coating improves esthetics but has some disadvantages. But there are controversial studies in the literature. When the frictional mannerof coated archwires was compared with noncoatedarchwires by the same manufacturer, coating was found to have an effect in decreasing friction. In contrast, a similar study described coatingas undurable.[4] Another study[5] found that, when coated, the colored wires are damaged from mastication forces and enzyme activities in the oral cavity.[2] Another researchers encountered difficulties with these coated archwires, expressing that the color tends to change with time and the coating splits during usage in the oral cavity, exposing the underlying metal.[6]

The color stability of esthetic archwires during orthodontic treatment is clinically important [Figure 1]. Ideally, the color of esthetic wires should match that of teeth and esthetic brackets. But the colors of natural teeth differs according to color measurement protocols used and by race, age, and gender.[7] Color changes can be examined using the CIE L*a*b* color system. This system is one of the most popular and universally used system for dentistry and many authors used this system to evaluate the perceptibility of color differences.[8,9] Silva *et al*[10] stated that all esthetic archwires assessed in their study showed noticeable color changes after 21 days in staining solutions. Coated

Address for correspondence: Dr. Sertac Aksakalli, Bezmialem Univ, Dis Hekimligi Fak, Ortodonti AD, Vatan cad. Istanbul, Turkey.
E-mail: sertacaksakal@gmail.com

wire NiTi (Trainerio, Rio Claro, SP, Brazil) and tooth tone plastic coated (Ortho organizers, Sao Marcos, Calif) wires showed less color change. Elayyan *et al*[5] stated that coated archwires had low esthetic value because 25% of coating was lost within 33 days *in vivo* and surface quality revealed severe deterioration.

Mechanical properties of orthodontic archwires can be determined by 3-point bending test. For 3-point bend test, a jig with two parallel brass rods with a diameter of 5 or 4 mm can be constructed. Two central incisor brackets are bonded on the top of these rods with aninterbracket distance of 14 mm [Figure 2]. Then the jig is transferred to the base of universal testing machine. This test evaluates the load-deflection property that is very important for nature of tooth movement and gives information about the behavior of the wires. The advantage of this test is close simulation to clinical application and ability to compare wires. It also has a high degree of reproducibility.[11] The 3-point bend tests produced load-deflection diagrams consisting of an upper loading curve and lower unloading curve. The difference between these curves represents hysteresis in the material. The loading curve resembles the force needed to engage the wire in the bracket. The unloading curve resembles the forces delivered to teeth during the leveling phase.[12] Elayyan *et al*[4] stated that"retrieved coated archwires produce lower unloading force values than as received coated archwires with conventional ligation." In another study,[5] it was stated that ultraesthetic coated archwires (GandH, Greenwood, Ind) produced lower loading and unloading forces than uncoated wires of the same nominal dimensions.With the Damon2 passive self-ligating brackets (Ormco, Orange, Calif, USA), retrieved rounded archwires showed no significant difference in loading and unloading forces compared with the as-received esthetic archwires at different loading and unloading forces.[5] The authors stated that this situation appears to be due to the fact that passive self-ligating braces make low friction and are not affected by the high surface roughness and detoriation of the coating.In a similar study performed by the same authors[4] it was concluded that the combination of Damon2 self-ligating brackets and Ultraesthetic coated wires (GandH, Greenwood, Ind) delivered low forces in both loading and unloading, and the combination of uncoated NiTi wires and conventional ligation delivered high forces.

Figure 1: An example of esthetic archwire (www.americanortho.com)

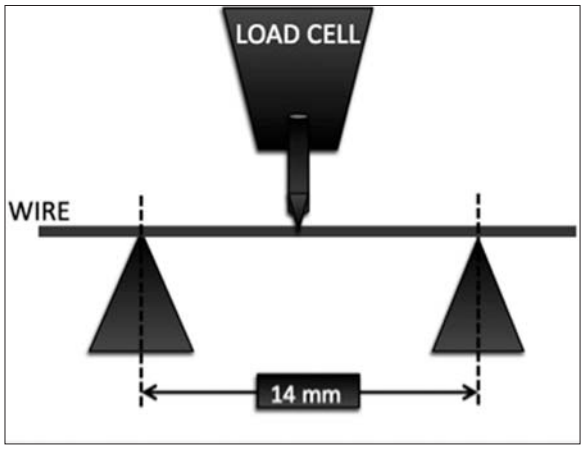

Figure 2: Three point bend test schema

Another important topic for the esthetic wire is surface roughness. The surface quality of wires affects the area of surface contact and influences its corrosion behavior and biocompability. There are lots of methods to determine surface roughness such as atomic force microscopy, spectroscopy, and contact surface profilometry.A profilometer device has diamond stylus attached to the instrument arm. When the stylus is drawn across the surface by the drive arm, the tip follows the profile of the surface by moving up and down. Each wire can be scanned at three different areas.Bouraulel *et al*[13] stated that there was high correspondence between all these methods when evaluating different archwires. When 3-point tests were performed, the surface roughness parameters revealed significant higher values, indicating greater surface roughness for the coated archwires.[5] After 4 weeks use in the mouth, Wichelhaus *et al*,[14] reported that there was an increase in surface roughness. Authors explained this situation by the abrasive effect of tooth brushing and the interaction between the archwire and brackets. Elayyan *et al*[5] stated that surface roughness of esthetic archwires increases after usage *in vivo*.

Surface topography including reflecting light images and scanning electron micrographs revealed delaminations, discolorations, ditching, and crackings in most cases when used approximately 5 weeks in the mouth. There were also high amounts of detoriation. By the help of quantitative analysis, it was detected that 25% of the coating was lost,

exposing the metallic surface below. The loss of surface coatings led to significant reduction of the esthetic quality. The coating peeled off in many areasduring *in vivo* usage.[5] It was stated that imprints of brackets and delamination areas were related to positions of the brackets in most cases. This result in the retrieved wires may explain the increase in friction found during mechanical testing. The authors also reported that irregular surfaces might lead to plaque accumulation and tooth movement might be affected due to entrapment of brackets inside these defects. This result is in agreement with another study.[15]

Appearance is one of the patients' main concerns during orthodontic treatment. There is a growing demand for esthetic orthodontic appliances and by the effect of this demand; most of the companiesproduced many new esthetic appliances. The new esthetic appliances provided better appearance for the patients and acceptable results for clinicians but these appliances must be studied by the researchers more and also must be developed.

References

1. Kaphoor AA, Sundareswaran S. Aesthetic nickel titanium wires--how much do they deliver? Eur J Orthod 2012;34:603-9.
2. Kusy RP. Orthodontic biomaterials:from the past to the present. Angle Orthod 2002;72:501-12.
3. Ramadan AA. Removing hepatitis C virus from polytetrafluoroethylene-coated orthodontic archwires and other dental instruments. East Mediterr Health J 2003;9:274-8.
4. Elayyan F, Silikas N, Bearn D. Mechanical properties of coated superelastic archwires in conventional and self-ligating orthodontic brackets. Am J Orthod Dentofacial Orthop 2010;137:213-7.
5. Elayyan F, Silikas N, Bearn D. Ex vivo surface and mechanical properties of coated orthodontic archwires. Eur J Orthod 2008;30:661-7.
6. Lim KF, Lew KK, Toh SL. Bending stiffness of two aesthetic orthodontic archwires:An in vitro comparative study. Clin Mater 1994;16:63-71.
7. Bolt RA, Bosch JJ, Coops JC. Influence of window size in small-window colour measurement, particularly of teeth. Phys Med Biol 1994;39:1133-42.
8. Stober T, Gilde H, Lenz P. Color stability of highly filled composite resin materials for facings. Dent Mater 2001;17:87-94.
9. Eliades T, Gioka C, Heim M, Eliades G, Makou M. Color stability of orthodontic adhesive resins. Angle Orthod 2004;74:391-3.
10. da Silva DL, Mattos CT, de Araujo MV, de Oliveira Ruellas AC. Color stability and fluorescence of different orthodontic esthetic archwires. Angle Orthod 2013;83:127-32.
11. Krishnan V, Kumar KJ. Mechanical properties and surface characteristics of three archwire alloys. Angle Orthod 2004;74:825-31.
12. Segner D, Ibe D. Properties of superelastic wires and their relevance to orthodontic treatment. Eur J Orthod 1995;17:395-402.
13. Bourauel C, Fries T, Drescher D, Plietsch R. Surface roughness of orthodontic wiresvia atomic force miscroscopy, laser spectular reflectance and profilometry. Eur J Orthod 1998;20:79-92.
14. Wichelhaus A, Geserick M, Hibst R, Sander FG. The effect of surface treatment and clinical use on friction in NiTi orthodontic wires. Dent Mater 2005;21:938-45.
15. Neumann P, Bourauel C, Jager A. Corrosion and permanent fracture resistance of coated and conventional orthodontic wires. J Mater Sci Mater Med 2002;13:141-7.

How to cite this article: Aksakalli S, Malkoc S. Esthetic orthodontic archwires: Literature review. J Orthod Res 2013;1:2-4.

Source of Support: Nil. **Conflict of Interest:** None declared.