Critical Review of Nickel Titanium Orthodontic Initial Arch Wires

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Abstract

Orthodontic archwires are used to increase the speed of alignment and minimize both pain and root resorption in patients. The most common initial archwire, NiTi, is a shape memory alloy with superelastic properties that delivers ideal light, continuous forces, due to a phase transformation between austenitic and martensitic crystal structures. When compared to stainless steel wires, NiTi provides an advantageous *in vivo* performance driven by a low stiffness, large springback, and high amount of stored energy; however, poor formability and joinability make installation more difficult. Despite the risk of releasing harmful Ni ions, NiTi exhibits good biocompatibility due to a manufacturer induced TiO_2 surface film. The TiO_2 film also shows an antiadherent effect, which prevents plaque accumulation and keeps friction to a minimum.

1. Background

1.1. A Brief History of Orthodontic Archwires

Archwires are metal wires that exert forces on the teeth in order to reposition the teeth into proper alignment (Fig. 1). Throughout the span of orthodontic treatment, archwires are exchanged for increasingly stiff wires that provide greater tooth movement. The first (initial) type of archwire, inserted at the beginning of the treatment sequence, corrects crowding and rotations of teeth [1]. Hence, an optimal archwire material is sought to increase the speed of alignment and minimize both root resorption and pain intensity of more than 4 million adolescents and adults undergoing orthodontic treatment annually [2].

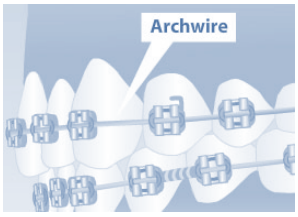

Figure 1. Orthodontic archwires exert forces on the teeth, guiding the repositioning of the teeth towards proper alignment [3].

By the 1960s, gold archwires were largely replaced by thinner, more resilient stainless steel wires [4]. Nickel titanium wires became prominent around 1974 because a low modulus of elasticity and extensive deactivation range allowed the application of constant lower forces over a longer period of time [4]. In 1986, the introduction of superelastic NiTi wires developed in both China and Japan further improved the performance of archwires [4]. The shift to a material