International Journal of Oral Health Dentistry 2022;8(1):27–30

Content available at: https://www.ipinnovative.com/open-access-journals

International Journal of Oral Health Dentistry

Journal homepage: www.ijohd.org

Review Article

Newer orthodontic archwires: A review

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ARTICLE INFO

Article history:
Received 09-03-2022
Accepted 14-03-2022
Available online 23-03-2022

Keywords:
Orthodontic archwires
Esthetics

ABSTRACT

Orthodontics is a constantly evolving science, with new biomaterials being invented regularly. Orthodontic archwires are an integral part of orthodontic fixed appliances and are necessary for the delivery of forces that brings about biologic tooth movement. As an orthodontist, one needs to have a thorough understanding of the various biomaterials available to make maximum use of these archwires and achieve clinical success. This article discusses the newest orthodontic archwires and evaluates the literature that pertains to these newer archwires.

1. Introduction

In orthodontics the main objective is to correct the malocclusion and achieve functionally stable and esthetic post-treatment results. To achieve the best results, optimal control of tooth movement is required, which can be delivered by applying an optimum level of orthodontic force using fixed orthodontics appliances incorporating orthodontic archwires, brackets, and various other attachments.

One of the main components of orthodontic appliances is orthodontic wires, which are available in different alloy combinations such as stainless steel, nickel-titanium, cobalt-chromium, titanium molybdenum alloy. Metallurgy is continuously evolving giving rise to newer and better biocompatible alloys. Orthodontists should have sound knowledge of the various orthodontic archwires to perform more efficient tooth movements without damaging the tooth and tooth-supporting structures.

Esthetics has been an important aspect of orthodontic treatment, and the introduction of esthetic brackets has necessitated the use of esthetic wires. Development of advanced orthodontic archwires that generate optimum forces to achieve biological orthodontic tooth movement without damaging the tooth and supporting periodontal structures resulting in short treatment time and reduced clinical follow-ups.[1] Teflon coated stainless steel wires, optiflex archwire, Titanium niobium wire, Bio force wire, combination wires, Copper-Niti, Fiber-reinforced composite archwire, Supercable, and Timolium wire are some of the newer archwires used in orthodontics.

The goal of this article is to review the literature relevant to the vast range of available orthodontic archwires and consolidate the information in order to make wire selection easier during fixed orthodontic mechanotherapy.

2. Copper NiTi

Rohit Sachdeva and Suichi Miyazaki are renowned for the most recent addition of copper NiTi archwire to the family of orthodontic wires in 1994. Copper NiTi contains alloy additions of 5-6% copper and 0.2 – 0.5g. Cr. Copper enhances the thermal reactive qualities of NiTi alloys and reduces hysteresis in the archwires and produces a constant unloading force. Copper, on the other hand, has the unintended consequence of elevating phase transformation

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https://doi.org/10.18231/j.ijohd.2022.007

temperature over that of the oral cavity. As a result, chromium is added to bring the phase transformation temperature back to 27 °C.

Wires come in three temperature transitions: 27, 35, and 40 degrees.[2] These wires exhibit shape memory in combination with high spring back, low stiffness, and super-elasticity. 35- and 45-degree transition temperature Cu NiTi wires exert low force levels on the tooth and tooth-supporting structures hence it is advantageous for periodontally compromised individuals furthermore, including copper in the alloy increases the transformation temperature range, bringing it closer to the oral cavity temperature levels. The archwire can be activated and deactivated by rinsing with warm and cold solutions.[3]

3. Bioforce Sentalloy – "A Graded Thermodynamic Wire"

The deactivation forces on individual segments of the orthodontic archwire were altered with the application of direct electric resistance heat treatment (DERHT) of the NiTi wires.[4] "Bioforce Sentalloy" archwires (GAC) can deliver targeted forces based on the needs of distinct arch sections.

These archwires are capable of delivering 80 gm of force for anterior teeth and approximately 320 gm for posterior tooth segments. Lower force levels in the anterior segment bring about efficient tooth movement without any unwanted complications also these archwires are easy to engage in crowding cases.

4. Super Cable Archwires

Hansen invented the 'supercable' super elastic nickel-titanium coaxial wire in 1993 which blended the mechanical properties of multi-stranded archwire cables and properties of superelastic archwires. Supercable is comprised of seven unique strands that are braided with each other in an elongated spiral to increase elasticity and flexibility and reduce force conveyance. At a deflection range of 1-3mm, only supercable wires 0.016" and 0.018" were verified with an unloading force of less than 100 gm.

Among the benefits were increased effective and simplified mechanotherapy, complete removal of archwire bending, the convenience of archwire engagement amidst crowding, modest anchor loss.

Supercable archwires have the disadvantage of fraying if it is not cut using sharp equipment. Wires breaking in extraction gaps, inability to form archwire bends, and the proclivity of terminal wire to move distally, creating soft tissue discomfort during leveling and alignment are some of the other disadvantages.[5]

5. Timolium Wire

TP orthodontics produces timolium, also known as Alpha-beta titanium alloy.[5] Timolium is primarily composed of titanium, with aluminum (Al) and vanadium (V) contributing as stabilizing agents. Approximately 85 percent of the material is titanium, 6.8 percent is aluminum, and 4.2 percent is vanadium. The α-phase of titanium is stabilized by aluminum at room temperature, while the β-phase is stabilized by vanadium.

These archwires blend stainless steel's stiffness and formability with NiTi's flexibility, light continuous force, and good spring back.

Scanning electron microscopy revealed low surface irregularities resulting in a significant decrease in friction. Although stainless-steel wires offer excellent strength and low friction to some extent, timolium wires, having a smooth even surface, decreased friction, low elastic modulus makes the archwire an alternative to stainless steel archwires.

6. Titanium Niobium Wire

These archwires were developed and introduced in the year 1995 by Rohit Sachdeva. Titanium nobium is a ductile alloy with a working range equivalent to stainless steel. It has a stiffness of approximately 20 percent less than that of TMA and 70 percent less than that of stainless steel. Titanium nobium archwires have a low spring back. It has a 48 percent lower bending stiffness and a 14 percent less spring back than stainless steel.

Archwire bends are easy to make. Weldability is good for titanium-niobium wires. Titanium nobium is only 36 percent as strong as steel under torsion, although it has a little higher spring back than stainless steel. This feature qualifies the Titanium nobium wire for even the most significant third-order adjustments. Finishing bends are possible thanks to the titanium-niobium archwire's minimal spring back and high formability. As a result of the features listed above, this wire can be considered as an alternate finishing archwire.[6]

7. Optiflex Archwire

Dr. Talass introduced the nonmetallic optiflex archwire in 1992, and Ormco manufactures it.

It is comprised of clear optical fiber and is completely stain-resistant and is a highly esthetic archwire.[7]

It is composed of three layers

1. Silicon dioxide core that generates tooth movement force.
2. A middle layer composed of silicon resin that increases strength and guards the core against moisture.
3. A nylon outer coating that is extremely stain-resistant and also increases the strength of these archwires.

Light continuous force, flexibility, and compatibility with various bracket systems can all be used to ensure efficient tooth movement. Sharp archwire bends must be avoided, and metal ligatures use is prohibited on these wires since they can damage the glass core.

Adult patients with esthetic concerns can benefit from Optiflex archwires. However, such wires are more expensive than metal wires, and their mechanical qualities are inferior.

8. Combined Wires

The anterior segment is composed of Titanal while stainless steel is used in the posterior segments. Lancer Pacific produces Titanal, a NiTi alloy. It is divided into three categories. Dual Flex-l, Dual Flex-2, and Dual Flex-3 are the three choices available.

The “Dual Flex-1” is composed of two different alloys in the anterior and posterior segments. The anterior section is titanal alloy and the posterior section is stainless steel. Using the "V" bend which is incorporated mesial in the posterior segment i.e., near the molars, the anterior elastic and flexible segment efficiently aligns the anterior tooth segments, while the stiff posterior segment preserves anchor and rotational control. It is administered at the initial stages of treatment. They’re especially effective with lingual appliances, which have a shorter inter bracket span in the anterior brackets.[8]

The “Dual Flex-2” is again comprised of a different dimension of anterior and posterior archwire segments. The anterior section is 0.016 x 0.022 inches whereas the posterior section is 0.018 inches. This particular configuration of the archwire prevents the anterior teeth from moving and anchors the anterior segment, while the posterior teeth mesial movement closes the extraction sites.[8]

The “Dual Flex-3” is almost similar to the “Dual Flex-2” archwire but the main difference is that the anterior segment is 0.017 x 0.025-inch dimensions.[8]

9. Fiber-reinforced Composite Archwire

Pultrusion is a method of fabricating fiber-reinforced composite archwires. Fiber bundles are passed through an extruder and saturated with a monomer resin. The monomer is then polymerized after being cured using heat and pressure. During the curing process, circular or rectangular wires are created. Further curing, also known as beta staging, can mold this into a distinct morphology. The only disadvantage is that at high loads and angulations, increased friction at the archwire-bracket interface is observed. As a result, glass fibers may be discharged into the mouth cavity.[9]

Fiber-reinforced composite wires have a better mix of high elastic recovery and high tensile strength than traditional metal wires. Great formability, excellent strength, minimal weight due to their translucency, and propensity to develop aesthetics for the same cross-section wires with varying stiffness values. These wires offer direct attachment bonding hence eliminating the requirement for welding and soldering. As these wires are nickel-free hence these seem to be a more secure option in nickel-allergic patients.

Burstone and Kuhlberg unveiled "Splint-It," a revolutionary fiber-reinforced composite containing Silica 2 glass fibers (S2) incorporated in bisphenol A-glycidyl methacrylate matrix. There are a number of configurations available, including unidirectional strips, woven strips, or ropy strips. Because these materials are only partially polymerized after production, they are flexible, malleable, and easy to mold on tooth surfaces. After light curing these archwires they become fully polymerized and hence can be used as post-treatment retention wires, full arch or segmental mechanics, and anchorage reinforcement.[10]

10. “Teflon Coated” Stainless Steel (Ss) Archwires

The major advantage of these archwires is the presence of a Teflon coating. Due to this particular coating, these archwires resemble or match the natural colour of human teeth. The epoxy-coated white stainless-steel wire from Lee is appropriate to be used with plastic or ceramic brackets.

11. Orthodontic Archwires Coated with Polyether Ether Ketone Tube (PEEK)

The advent of the PEEK tube marks the rise of advanced estheic archwires.

A polyether ether ketone resin tube served as an auxiliary through which the orthodontic archwire is passed. The colour difference between the PEEK tube and coated wires was practically identical, demonstrating a sufficient esthetic feature. Passing the archwires through the PEEK tubes resulted in lower frictional force. It has a good cosmetic and mechanical combination for usage in orthodontic appliances.[11]

12. Conclusion

Orthodontic wires are an integral part of orthodontic appliances since the force used to move teeth is determined by the alloy used in the archwires. As orthodontic biomaterials science is constantly advancing and newer materials are being discovered, an orthodontist must have a comprehensive understanding of orthodontic wires to achieve high clinical success and favorable treatment outcomes.

13. Source of Funding

None.

14. Conflict of Interest

The authors declare no conflict of interest.

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Cite this article: Pathak P, Banerjee R, Duseja S, Sharma T. Newer orthodontic archwires: A review. *Int J Oral Health Dent* 2022;8(1):27-30.