ORIGINAL RESEARCH

Orthodontic Archwires: An Update

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Abstract

Today more than 100 years have passed since Dr. Edward Angle placed his first archwire into a patient's mouth and orthodontics began. It was during that period many innovations did occur that have been explained in terms of art. As time passed, scientifically based orthodontics evolved, and we see from that time, many new innovations in material science have summed up with new treatment approaches and modalities. However, when we turn around and see the developments and innovations in material science, we stand with pride: but the urge to make treatment still more comfortable and less time-consuming has led us to the introduction of a plethora of new orthodontic materials and products that represent a significant improvement over their predecessors. This article compiles all archwire from Angle era till recent available newer archwire.

Keywords: Coated archwires, Esthetic archwires, Newer archwires, Variety of archwires.

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Introduction

One of the oldest specialties, orthodontics, has changed dramatically in the last few decades. In the 21st century, contrary to earlier times, there is now a noticeable increase in the number of adult patients seeking orthodontic care. Higher-quality alloys that are more physiologically effective for teeth and supporting tissues are required by the evaluation of wire manufacturing processes and the development of novel orthodontic treatments.[1] Adult patients seeking orthodontic treatment are most concerned about the unattractive looks brought on by the metallic appearance of orthodontic brackets and wires, longer treatment time frames needing several appointments, and ambiguity during therapy.[2] Cosmetic archwires were created in response to the demand for esthetic orthodontic treatment solutions. Both greater clinical performance and superior esthetics are the goals of these newer archwires. Coated wire and uncoated wire are currently the two primary varieties of esthetic archwires. Understanding how the energy available for tooth movement varies with wire composition for the same diameter wire is crucial when new alloys are developed. Dentists must make important choices regarding wire selection due to the large range of orthodontic wire alloys available. This article's goal is to review the literature that is currently available on these popular archwires in order to gain information that will help with wire selection at particular treatment stages. The future of orthodontics depends on effective and esthetic treatments.[3]

Supercable Archwires

It was introduced by Hansen in 1993, a superelastic nickel-titanium coaxial wire known as "Supercable" (Fig. 1) combines the features of superelastic bends with the mechanical benefits of multicore cables.[1] To enhance flexibility and reduce power transfer, they are made up of seven separate strands that are weaved into a long, gentle spiral. The advantages of archwires consist of improved treatment effectiveness, streamlined mechanotherapy, restricted archwire flexion, flexibility, and convenience of use even in crowded, reduced anchor loss, and no harm to supporting periodontal tissue. These include light continuous force to eliminate reaction, minimization of patient discomfort after initial archwire placement, and reduced patient numbers. The number of visits decreases due to the longer activation time of the arch.[2] However, it is not without its drawbacks. Other drawbacks include the tendency of the wire to break or collapse in the extraction space, the inability to bend, step or spiral, and the tendency of the wire end to move distally, resulting in tooth movement, and so on. For example, when they start to align, they tend to irritate soft tissues.

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TiMolium Wire

It is a product made by TP Orthodontics and is also known as Alpha Beta Titanium Alloy. These archwires combine stainless steel wire's high stiffness and ductility with NiTi's flexibility, long-lasting strength, and durability.[3] Aluminum and vanadium serve as stabilizers, and titanium serves as the major constituent of titanium. Over 85% of the material is titanium, 6.8% is aluminum, and 4.2% is vanadium. Titanium's alpha and beta phases are stabilized by aluminum and vanadium, respectively, at ambient temperature. Due to the combination of stabilizing components and the alpha and beta phases of titanium alloys it includes, this alloy demonstrates a unique combination of strength and surface smoothness.[4] Scanning electron microscope surface analysis of the tiMolium wire's surface revealed a flat surface with a few minor irregularities (Fig. 2), greatly lowering friction. Stainless steel is the most widely used archwire in orthodontic mechanical therapy

Fig. 1: Supercable archwire

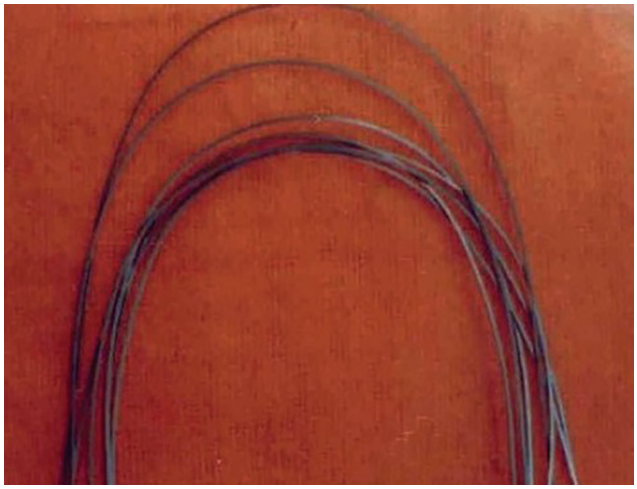

Fig. 2: TiMolium wire

because of its high strength, low friction, and smooth surface. It also has a smooth surface and a low friction surface. Another option is tiMolium, which has a low modulus and strong strength.

Titanium Niobium Wires

This archwire provides a precise finish from tooth to tooth. The wire stiffness is 80% of TMA wire.[2] Although it is soft and supple, its restoring force after bending is equivalent to that of stainless-steel wire. The primary characteristics of this wire—used as an end wire—include softness and malleability, bending stiffness that is half that of stainless steel, spring back during bending that is 14% less than that of stainless steel, and high weldability.

Bioforce Wires

This is a new invention brought about by GAC and has the unusual ability to vary the transition temperature inside the same archwire.[4] The low reflectance rhodium-plated white appearance provides high esthetics to the archwire. These archwires allow a gradual transfer of force by applying a weaker force to the front teeth and a progressively stronger force to the back teeth until the molar plateau is reached. Force levels are therefore graded according to tooth size across the arc length. This wire, which goes from about

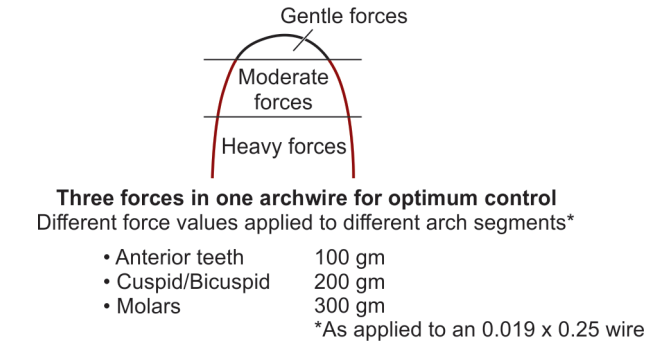

Fig. 3: Tri-Force wire

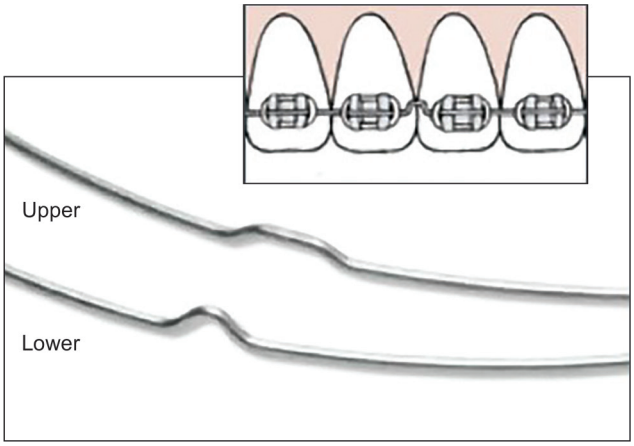

Fig. 4: Drift-free archwire

100–300 gm, applies the ideal amount of force to each tooth, lowering the number of wire changes and enhancing patient comfort. They are the first wires that are properly organic.

Tri-Force Wires

These wires are pre-programmed to exert just the proper amount of pressure in each mouth region, utilize firm pressure on the molars, medium pressure on the premolars, and gentle pressure on the incisors. These austenitic wires deliver dependable performance, prevent molar tilting, unintentional premolar rotation, and mild impacts on the front teeth that do not hurt. Three-dimensional control is available with Trioforce (Fig. 3) right from the beginning of treatment.[4]

Drift-free Arch Wires

The drift-free archwire (Fig. 4) includes a midline stop to prevent lateral displacement of the archwire. This is because the movement of the archwire can lead to damage to the buccal mucosa. A permanent centerline stop also serves as a reference point.[3]

Triangular Wires

In 2001, Broussard and Graham released triangular stainless-steel wires for orthodontic use (Fig. 5). These triangular wires have rounded edges and 0.030-inch cross-sections on one side, making them equilateral triangles. For bending, specialized pliers are needed. These wires can be utilized to create integrated lingual retainers, removal tools, and retainers. Round wires cause occlusal interference, so using a triangular wire that fits more easily between teeth than a round wire can solve the problem. The flat surface of

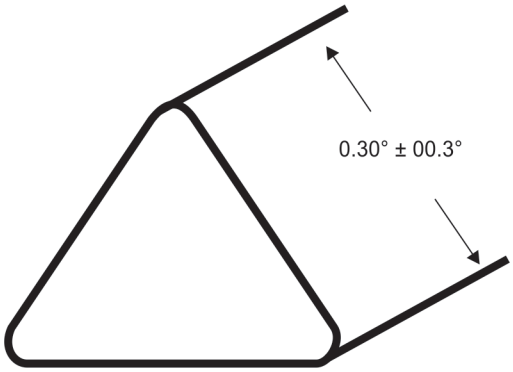

Fig. 5: Triangular wire

Fig. 6: Hills dual-geometry archwire

the triangular wire reduces wobble and tooth wear compared to the round wire of the Hawley Labial Wire.[3]

Medical-grade Titanium Alloy Wire

Nickel, copper, molybdenum, and chromium are allergens, so medical-grade titanium alloys are pure titanium alloys of choice for the most sensitive patients.[5]

Hills Dual-geometry Archwire

Designed as a perfect wire for sliding posterior machines through polished rounded back teeth, the square anterior teeth provide maximum torque control on the anterior crowns. Hills Dual-geometry Archwires (Fig. 6) are constructed of ultrahigh strength stainless steel for optimal stiffness.[6] Hills archwires are available in two sizes: 0.018 × 0.018" front and 0.018" rounded rear for 0.018 slots and 0.020" rounded rear and 0.021 × 0.021" front for 0.022 slots.

Speed Finishing Archwires

The final archwire for "SPEED" (Fig. 7) has a sloping labial-gingival shape that makes it easy to depict how the superelastic spring clip interacts with the archwire and archwire slot. If the clip is misaligned with the wire, the spring clip will bend and store enough energy to recover. Precise 3D tooth implantation softly releases this energy. Additionally, the arched design of this quadrant makes it easier to enter wire and close spring clips. Wires are available in either 0.017 × 0.022" for 0.018 slots or 0.020 × 0.025" for 0.022 slots.[6]

Fig. 7: Speed-finishing archwire

Fig. 8: Smart archwire

SmartArch Multi-force Superelastic Archwires

SmartArch wire (Fig. 8) is manufactured using a method known as multiple memory materials technology. This method precisely programs a transition zone as small as 0.001 inches in the cross-section of the shape memory alloy wire.[7] SmartArch wire can be used to maintain optimized physiology. Force lasts for a long time. With carefully applied orthodontic mechanics, SmartArch wires shorten lag periods, reduce adjustment and reactivation requirements, eliminate indeterminate mechanics, and increase orthodontic efficiency. Copper NiTi Smart Archwire that is terminated with a TMA or stainless-steel arch measures 0.018" × 0.025".

New Bactericide Orthodontic Archwire

NiTi archwires containing silver nanoparticles apply force to the teeth when inserted into slots in brackets that are glued to the labial or lingual surfaces of the teeth. Oral hygiene then becomes more complicated for the patient. Normal development of dental biofilms is facilitated by the accumulation of plaque around brackets. Subsequently, enamel deterioration or gingivitis may develop, and further periodontitis is a real situation.[7] Therefore, this new bactericidal NiTi orthodontic archwire was developed by electrodeposition of silver nanoparticles without losing the mechanical properties helps to reduce plaque accumulation. Bacterial culture results showed that the presence of silver nanoparticles reduced bacteria by more than 90%. As a result, the novel silver nanoparticle treatment may be a good candidate as a bactericidal orthodontic archwire.[7]

Turbo Wire

A 9-strand rectangular NiTi braid with low stiffness and high flexibility is called a turbo wire (Fig. 9). It is advised to thoroughly

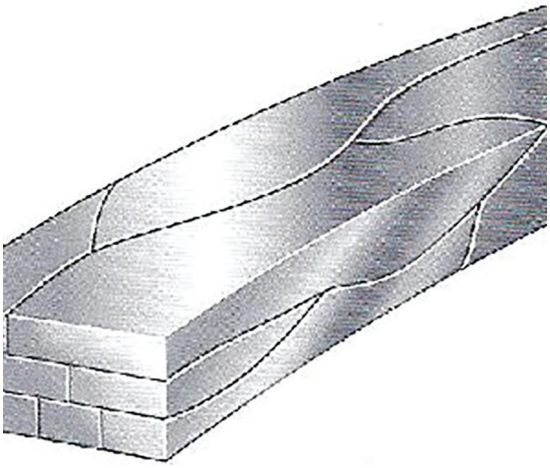

Fig. 9: Turbo wire

Fig. 10: Bio-Twist

engage the slots, manage the torque, and untangle the arches before leveling them. It works well as a finishing wire and may be utilized elastically while maintaining torque in the vertical direction.

Bio-Twist NiTi

The Bio-Twist (Fig. 10) is a 0.021 × 0.025 shaped rectangular archwire constructed from multiple strands of superelastic titanium wire. This multi-strand construction makes the wire less strong and stiffer and more flexible. The rectangular shape also greatly improves slot engagement, this wire can also be applied toward the end of a procedure where it is crucial to keep the torque constant.

Retranol

The reverse curved archwire of the Retranol Bite Opener is made of work-hardened NiTi. This wire offers a wider working range than stainless steel wire and provides ideal shape stability to prevent tipping of the anterior teeth when retracting. This wire requires fewer archwire changes and adjustments. Retranol remains active throughout treatment without deformation. It is available in round and rectangular, arc shapes.

Menzamium Wire

Manganese and nitrogen replace the allergenic components of nickel during the revolutionary high-pressure melting process used to create stainless steel, ideal for people with nickel sensitivity. Additionally, it resists corrosion and is strong.[3]

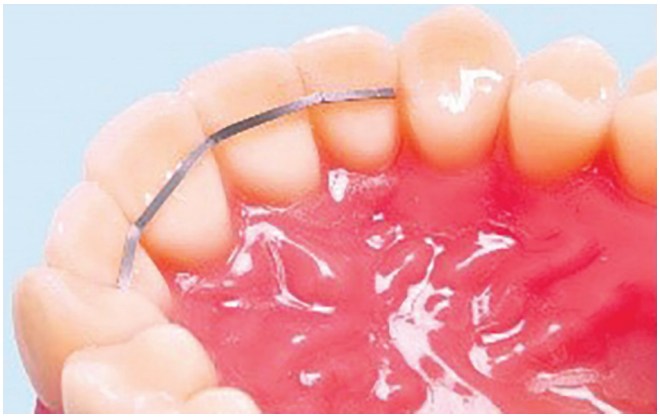

Fig. 11: Dead-soft security archwire

Fig. 12: Fiber-reinforced composite archwire

Dead-soft Security Archwire

By Binder and Scott, the dead-soft archwire (Fig. 11) was first presented. After bonding, an archwire is typically put into start tooth movement for nonextracted teeth. Using the proper archwire, however, may cause a tooth to shift before extraction when a tooth is being extracted.[2] Use two twisted strands of dead soft 0.008" or 0.010" dead-soft SS ligature wire or a half archwire made of dead soft brass wire to get around this issue.

Esthetic Archwires

Fiber-reinforced Composites (FRC) as Archwire

Fiber-reinforced composites are made of S-2 fiberglass (ceramic) and acrylic resin (polymer). Fiber-reinforced composites (Fig. 12) use "prepregs" or partially polymerized fiber matrix composites that are fully polymerized in a clinical setting. Its greatest use – is an aid to active tooth movement. Fiber-reinforced composites have good adhesion properties to the teeth and to the appliance itself. One FRC can be linked to another to add attachments directly.[3]

Advantage

The connecting rods are transparent or translucent, which is esthetically pleasing. It is biocompatible and has a high flexural modulus. Attachments can be added for intermaxillary motion

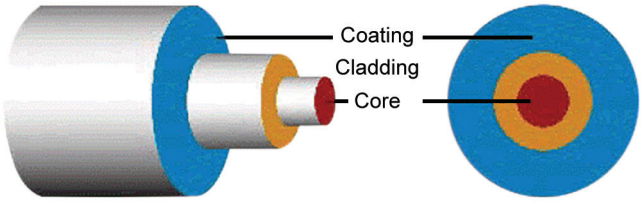

Fig. 13: Optiflex archwire

without the use of bands or brackets, allowing hooks to be easily positioned with ideal alignment and force application. Vertical elastics can be attached directly to his FRC rods to complete arches or segments and close open bites.

Limitation

Fiber-reinforced composite bars are strongest and most rigid in tension, weakest in shear and torsion, and least strong in bending mode. It is not a homogeneous material, unlike metals, thus, shear stress needs to be kept to a minimum. Technology for dependable connections is necessary.

Optiflex Archwire

Dr. Talass created the esthetic non-metallic orthodontic labial arch wire known as Optiflex (Fig. 13) in 1992, and Ormco produced it, made of transparent optical fiber, that is stain- and fade-resistant and has great mechanical qualities. It has three levels.

(a) A core made of silicon dioxide provides the force needed to move the teeth. (b) An intermediary layer made of silicon resin shields the core from moisture and boosts strength. (c) A nylon outer layer that is resistant to strain, shields the wire from deterioration and increases strength. The effective tooth movement with less sustained effort and greater flexibility of Optiflex archwires make them advantageous for orthodontic treatment. It can thus be applied generally to various bracketing systems. However, avoid sharply bending the wire. Avoid using metal ligatures since they could shatter the glass core. Use the Mini Distal End Cutter, which can cut all three layers of his Optiflex, to cut the wire's distal end. Adult patients who are concerned about their appearance utilize it.[5] The initial alignment can be done using Optiflex wire. Compared to coaxial wires, less force is produced for the same amount of deflection. The costly Optiflex archwires must be changed every 4–6 weeks.

Polynorbogen

It is developed in Japan, the wire is based on shape memory. It starts to exhibit an elastic property and returns to its former shape once the temperature reaches the glass transition point of 35°C.[5] At 50°C, it may be stretched to double its original length.

Combined Wires

The combined wire (Fig. 14) has a titanium anterior portion and a stainless-steel posterior piece offered in three varieties.[2]

- Dual Flex-I
- Dual Flex-2
- Dual Flex-3
  - *The Dual Flex-1:* 0.016-inch-round steel for the posterior segment and 0.016-inch-round titanium for the anterior section. Cast ball hooks are connected to the cuspids mesially at the point where the two segments converge.

Fig. 14: Combined wire

The hard posterior teeth maintain anchorage and control of the molars by a mesial "V" bend to the molars, whereas the flexible anterior teeth are easily aligned. It was given at the beginning of the course of treatment.[2]

  - *The Dual Flex-2:* It consists of a flexible front segment wire of a 0.016 × 0.022" rectangular titanal and a rigid posterior segment of round 0.018" steel.[2] The rectangular anterior segment of titanal when engaged in the bracket slots prevents movement of anteriors while closing the remaining extraction site by the mesial movement of the posterior teeth.
  - *The Dual Flex-3:* It consists of a flexible anterior part of a 0.017 × 0.025" titanal rectangular wire and a posterior part of 0.018 square steel wire. Dual Flex 2 and 3 wires enable anterior anchorage and close the posterior gap while controlling molar rotation.

    A considerable amount of anterior torque can also be initiated with the wire.[2]

Coated Wires

- *Epoxy-coated archwire:* Archwire that is tooth-colored. It has great abrasion resistance and a 4–8-week color stability.[8]
- *Lee white wire:* This strong archwire is made of stainless steel or has a NiTi color coating. Ceramic and plastic brackets can be used with it. Epoxy has no flaws such as peeling, chipping, or discoloration, and is entirely opaque.
- *Marsenol:* A NiTi wire with a tooth-colored coating made of elastomer polytetrafluoroethylene emulsion is known as marsenol (ETE). It functions in the same way as an uncoated highly elastic NiTi wire.
- *Filaflex:* High-tensile SS core.
- *Orthocosmetic elastinol*: It is a high-performance, extremely elastic NiTi archwire with an esthetic coating. With ceramic or plastic brackets, the esthetically pleasing finish works well. No stains or discolorations, and it resists chipping or cracking.[8]
- *Titanium tooth-toned archwire:* NiTi wire that is exceptionally elastic has a unique plastic and tooth-colored coating to prevent abrasion. It combines well with composite brackets, ceramic, plastic, and natural teeth.
- *Imagination wire:* Presented by Swedish company Gastenco, decreases friction when used with image brackets, has superb esthetics, and is also hypoallergenic.

- *Polyphenylene polymers esthetic orthodontic archwires:* The wire's tensile, flexure, spring-back, stress-relaxation, and formability were all improved by adding polyphenylene (Primospire, Solvay Advanced Polymers, and Alpharetta, Ga.) polymer to wires with clinically significant round and rectangular cross-sections.[8]
- *Teflon-coated stainless-steel archwires:* Teflon coating gives teeth their natural color. The coating is put to the wire using an atomic method, leaving a layer that is 20–25 m thick. The teflon coating shields the wire against corrosion.

Conclusion

The only orthodontic archwire was made of gold up to the 1930s. Recent developments in orthodontic wire alloys have led to the creation of a variety of wires with a remarkable array of characteristics. All available wire kinds can be used effectively to satisfy the patient's esthetic goals while also enhancing patient comfort and cutting down on treatment time and length. Many conventional procedures have been replaced by more advanced materials and processes, but it is crucial to keep in mind that no archwire is perfect or appropriate for every stage of therapy. Since archwires are the main driving force behind the orthodontic treatment, being aware of new archwires will enable you to select the ideal wire for your requirements.

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