Newer Orthodontic Archwires: Imparting Efficacy to Esthetics

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Abstract

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Introduction

Orthodontics is the oldest specialty that has undergone drastic transformation in the past few decades. As we progress into the 21st century, orthodontists worldwide are experiencing plodding significant change in their treatment modalities and aesthetic concepts[1]. In contrast to the past, the number of adult patients seeking orthodontic treatment has increased considerably. Though adult patients co-operate better than adolescents, they present a different set of challenges for the orthodontist. The unaesthetic appearance due to metallic show of orthodontic brackets and wires, the longer span of treatment requiring multiple clinical appointments and obscurity during the treatment period was of primary concern for adult patients seeking orthodontic treatment. The primary concern of adult patients is improved esthetics during treatment and good treatment results. The development of an appliance combining both esthetics and efficiency is the ultimate goal for a successful orthodontic practice in the present era. Presently even the younger generation is very much concerned about their looks during the treatment period.

Due to the significantly increasing demand for esthetics during fixed appliance therapy, esthetic brackets have been introduced. The advent of esthetic brackets in orthodontics created a need for esthetic arch wires. There are newer wires presently available in the market that delivers optimum forces to teeth which results in minimal patient discomfort, reduced span of treatment and minimal clinical appointments[2]. Newer arch wires introduced in orthodontics include supercable, copper- Niti, timolium wire, titanium niobium wire, optiflex archwire, bioforce wire, combined wires, fiber reinforced composite archwire, teflon coated stainless steel wires and marsenol. This article reviews the existing literature on the topic of newer archwires.

Copper- NiTi

It was Dr. Rohit Sachdeva who introduced a quartenary alloy of Nickel, Titanium and Copper & Chromium in 1994. This NiTi had both superelastic and shape memory properties. Due to the incorporation of copper these wires have better defined thermal properties than NiTi superelastic wires and showed better control over tooth movement. Wires are available in 3-transition temperatures 27, 35 & 40 degrees[5]. These third generation wires have shape-memory in addition to the low stiffness, high spring back, and super-elasticity of the first and second generation NiTi wires. The temperature range for the transition of martensitic to the austenitic phase forms the basis of the shape memory phenomenon. This was considered too low to be practical for orthodontic treatment earlier. The addition of copper to the alloy increases the transition temperature range approximating the intraoral temperature. This helps the patient to activate and de-activate the arch-wire by rinsing with warm and cold beverages[3].

Super cable arch wires

Super elastic nickel titanium coaxial wire known as ‘supercable’ introduced by Hansen in 1993 united the mechanical advantages of multi stranded cables and the properties of super elastic archwires. These comprises of seven individual strands that are woven together in a long gentle spiral to maximize flexibility and minimize force delivery[4]. Advantages included improved treatment efficiency, simplified mechanotherapy, elimination of archwire bending, flexibility, ease of engagement regardless of crowding, minimal anchor loss, a light continuous force eliminating any adverse response of the supporting periodontium, minimal patient discomfort after initial archwire placement and fewer patient visits due to longer archwire activation periods[5]. But they are not devoid of any disadvantages. The wire ends have a tendency to fray if not cut with sharp instruments. Other disadvantages includes tendency of wires to split and untangle in extraction spaces, inability to create bends, steps, or helices and tendency of wire ends to migrate distally leading to soft tissue irritation as the teeth begins to align[6].

Timolium wire

This is also called Alpha – beta titanium alloy, manufactured by TP Orthodontics[6].These archwires combine the flexibility, continuous force and spring back of Ni-Ti with the high stiffness and bendability of stainless steel wire. Titanium is the major constituent of Timolium with aluminum and vanadium as stabilizing agents. The composition is titanium more than 85%, Aluminum 6.8% and Vanadium 4.2%. Aluminum stabilizes the alpha phase of titanium to room temperature, whereas vanadium stabilizes the beta phase. This alloy contains both stabilizing elements and both alpha and beta phases of titanium alloy and thus display a rare combination of strength and surface smoothness. Surface evaluation by scanning electron microscopy revealed a smooth surface with little surface irregularity for Timolium archwires considerably reducing the friction to a great extent. Though stainless steel with high values for strength, low friction, and smooth surface continues to be most commonly used archwire in orthodontic mechanotherapy, Timolium with its smooth surface, reduced friction, low modulus, and better strength could be also considered as a breakthrough in clinical orthodontic practice.[7]

Titanium niobium wire

It was introduced by Dr. Rohit Sachdeva in1995 & is presently manufactured by Ormco. Ti- nb is soft and easy to form and has similar working range of stainless steel. Its stiffness is 20% lower than TMA and 70% lower than stainless steel. Ti-nb wires have a larger plastic range, similar activation and deactivation curves and relatively low spring back. Its bending stiffness is 48% lower than that of stainless steel and a spring back 14% lower than that of stainless steel. Bends can be made easily in this wire and also avoids excessive force levels of a steel wire. The titanium-niobium wires have good weld ability. The stiffness of ti-nb in torsion is only 36% of steel, but the spring back in torsional mode is slightly higher than stainless steel. This property makes the ti-nb wire suitable for even the major third order corrections. The low spring back and high formability of the titanium-niobium arch wire allows creation of finishing bends. Hence, this wire can be used as a finishing archwire[8].

Optiflex archwire

Optiflex is a totally esthetic non-metallic labial orthodontic arch wire designed by Dr. Talass in1992 and manufactured by Ormco. It is made of clear optical fibre with distinctive mechanical properties with highly esthetic appearance and entirely stain resistant[9]. It consists of ***3 layers***.

a. A ***silicon dioxide core*** which provides the force for tooth movement.
b. A ***silicon resin*** middle layer which protects the core form moisture and adds strength.
c. A ***strain resistant nylon*** outer layer which prevents wire damage and further increases strength

Orthodontically beneficial properties of optiflex arch wires includes efficient tooth movement with light continuous force,increased flexibility producing a wide range of action thus invariably permitting its use with various bracket systems. However sharp bends in the wire should not be attempted. Metal ligatures should not be used as they can fracture the glass core. When cutting the distal ends of the wire use the mini distal end cutter, which is designed to cut all the 3 layers of Optiflex. It is used in adult patients who are esthetically concerned. Optiflex wire can be used for initial alignment. It produces less force for the same amount of deflection when compared with coaxial wires. The optiflex archwires are expensive and needs to be changed every 4-6 weeks[10].

Bioforce Wire

It was introduced by GAC with the unique property of variable transition temperatures within the same archwire. They are high aesthetic archwires having a proprietary low-reflectivity rhodium coating giving a white appearance[11]. These archwires allows graded force delivery by applying low gentle forces to the anteriors and increasingly stronger forces across the posteriors until plateauing at the molars. The level of force is thus graded throughout the arch length according to the tooth size. Beginning at around 100g and increasing to 300g, this wire provides the right force to each tooth, reducing the number of wire changes and provides greater patient comfort. They are the first biologically correct arch wires[4].

Combined wires

The anterior portion of combined wire is made of titanal and posterior part is of stainless steel. Titanal is a nickel titanium alloy manufactured by Lancer Pacific. It consists of 3 types. 1. Dual Flex-l, 2. Dual Flex-2, and 3.Dual Flex-3.

The Dual Flex-1: It consists of ananterior section made of 0.016-inch round titanal and a posterior section made of 0.016-inch round steel. At the junction of the two segments, cast ball hooks are present mesial to the cuspids. The flexible front part easily aligns the anterior teeth and the rigid posterior part maintains the anchorage and molar control by means of the “V” bend, mesial to the molars. It is used at the beginning of treatment. They are very useful with the lingual appliance, where anterior inter bracket span is less[12].

The Dual Flex-2: It consists of a flexible front segment composed of a 0.016 x 0.022” rectangular titanal and a rigid posterior segment of round 0.018” steel. The rectangular anterior titanal segment when engaged in the bracket slots impedes movement of the anterior teeth, while closing the remaining extraction sites by mesial movement of the posterior teeth[12].

The Dual Flex-3:This consists of a flexible anterior part of a 0.017 X 0.025-inch titanal rectangular wire and a posterior part of 0.018 square steel wire. The Dual Flex-2 and 3 wires provide anterior anchorage and control molar rotation during the closure of posterior spaces. They also initiate considerable anterior torque[12].

Fiber reinforced composite archwire

Fiber reinforced composite arch wires are fabricated using a procedure called pultrusion. Fiber bundles are pulled through an extruder, in which they are wetted with a monomer resin. Then the monomer is cured with heat and pressure resulting in polymerization. Circular or rectangular wires are formed during curing. This may be shaped into a different morphology by further curing, a process known as beta staging. For this, the monomer should initially only be partially cured. The composite archwires have higher kinetic coefficients of friction than stainless steel but lower coefficients than either Nickel-titanium or Beta-Titanium. At high forces and angulations abrasive wear of the composite surface at the archwire-bracket interface was observed. It can lead to release of glass fibers within the oral cavity, which is unacceptable[13].

Advantages of fiber reinforced composite wires over conventional metal wires are excellent combination of high elastic recovery, high tensile strength, low weight, excellent formability, excellent esthetics because of their translucency, ability to form wires of different stiffness values for the same cross-section which would facilitate the practice of constant cross-section orthodontics. Attachments can be directly bonded to these wires, which eliminate the need for soldering and welding. These wires can also be directly bonded to teeth obviating the need for brackets, in certain situations, e.g. where anchorage from a large number of teeth is required. It is a safer choice for patients with nickel allergy[14,15].

Composite archwires had higher kinetic coefficients of friction than stainless steel but lower than nickel-Titanium or beta titanium. The composite archwire retained sufficient resilience to function during initial stage of orthodontic treatment and also during intermediate stages of orthodontic treatment.[13]

Burstone and Kuhlberg introduced a new fiber reinforced composite called "Splint-It" which has S2 glass fibers in a bis GMA matrix. Various configurations such as rope, woven strip and unidirectional strip are available. These materials are only partly polymerized during manufacture, which makes them flexible, adaptable and easily contourable over the teeth. Later they are completely polymerized and can be bonded directly to teeth. It can also be used for various purposes such as post treatment retention, as full arches or sectional arches, and to reinforce anchorage.[16]

Teflon coated stainless steel wires

Teflon coating imparts to the wire a hue, which is similar to that of natural teeth. This coating protects the wire from the corrosion process. **Lee white stainless steel** wire has an epoxy coating and is suitable with plastic or ceramic brackets.[4]

Marsenol

This is a tooth colored Nickel Titanium wire coated with an elastomeric poly tetra fluroethyl emulsion exhibiting all the same working characteristics of an uncoated super elastic Nickel Titanium wire, manufactured by Glenroe technologies[4].

Conclusion

Recent advances in orthodontic wire alloys have resulted in a varied array of wires that exhibit a wide spectrum of properties. Appropriate use of these wires may enhance the patient comfort; reduce the chair side time and duration of the treatment. Though superior materials and techniques are now available and many replace conventional methods, one should keep in mind that no arch wire is ideal or best for all stages of treatment. Since arch wires are the main force system in orthodontics, the knowledge about newer arch wires will help us to select the appropriate wire within the context of their intended use during treatment.

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