Newer orthodontic wires: A Revolution in orthodontics- A Review

Abstract
Orthodontics has achieved the status of a recognized specialty of dentistry because of a long period of craftsmanship and professional expertise. The evolution of wire manufacturing technology and the development of new orthodontic techniques have led to the search for better quality alloys, more biologically effective for the teeth and supporting tissues. Esthetics has become an important and integral part of the orthodontic treatment. With the advent of revolutionary esthetic brackets, the need for the esthetic wires became very strong. Traditionally, brackets as well as archwires were manufactured with Stainless steel or Chrome-Cobalt alloy. Titanium and its alloys have also found their application in this field. With the steady increase in demand for more esthetic orthodontic appliances, Ceramics and polycarbonates have been used to produce tooth colored brackets, and research is under way to produce a suitable archwire material, which will combine esthetics with the required mechanical properties. Future of orthodontics lies in the effective and esthetic treatment.

Key words: esthetics wire, bioforce, composite wire

Introduction
Orthodontic tooth movement is carried out, by engaging successively increasing sizes of archwires in brackets, which are bonded to the teeth. Traditionally, brackets as well as archwires were manufactured with Stainless steel or Chrome-Cobalt alloy. Titanium and its alloys have also found their application in orthodontics. With the steady increase in the number of adults undergoing orthodontic treatment, there has been a corresponding increase in demand for more esthetic orthodontic appliances. Ceramics and polycarbonates have been used to produce tooth colored brackets, and research is under way to produce a suitable archwire material, which will combine esthetics with the required mechanical properties.

Desirable tooth movement can best be achieved by producing an optimal force system, which has the following biomechanical characteristics: Moderate to low force magnitude, which will allow rapid and relatively painless tooth movement, with minimal tissue damage. Constant force level over time, as the appliance experiences de-activation, in order to provide maximum tissue response. Ability of the appliance to undergo large deflections without deformation.

Historically, the force magnitude applied to teeth has been controlled, by varying the cross-section of the wire used in the appliance. Small wires have been used to achieve large deflections while applying low forces on the teeth. On the other hand, larger wires that fit well into the bracket slots have been used to carry out precise and controlled tooth movement.

Teflon coating imparts to the wire a hue which is similar to that of natural teeth. The coating is applied by an atomic process that forms a layer of about 20-25μm thickness on the wire. This layer then undergoes a heating process and acquires a surface with excellent sliding properties. Polyethylene, commonly known as Teflon, is a semi-crystalline thermoplastic polymer with a very low coefficient of friction. Its surface is smooth and slippery, allowing the wire to slide against the bracket without the traditional friction. The stiffness of Ti-Nb in torsion is only 36% of steel, yet the springback of Ti-Nb in torsional mode is slightly higher than the other wires.
higher than stainless steel, this property makes it possible to utilize the Ti-Nb wire for even the major third order corrections. Timiolium Titanium Wire

Timiolium archwires combine the flexibility, continuous force and springback of nickel titanium with the high stiffness and bendability of stainless steel wire [16]. When compared to Nickel Titanium or Beta Titanium wire, Timiolium outperforms in the following: More resistant to breakage for reduced friction. Brightly polished and aesthetically pleasing. Nickel free for sensitive patients, Easier to bend and shape. Can be welded.

Loops and bends can be made without breakage. Timiolium wire is excellent for all phases of treatment. During initial treatment, it is excellent for space closure, tooth alignment, levelling and bite opening. Early torque control can begin during intermediate treatment because of the moderate forces delivered. Total control during detailing makes Timiolium the wire of choice during the final treatment phase.

Bioforce Arch Wires

It is possible to produce variation in arch wire force delivery between archwires of identical dimension by specifying transition temperatures within given ranges. These are graded thermodynamic arch wires. The manufacturers have taken this process are step further, by introducing variable transition temperatures within the same archwire. BioForce High Aesthetic is part of the first and only family of biologically correct archwires. The NiTi BioForce wires apply low, gentle forces to the anterior and increasing stronger forces across the posterior until plateauing at the molars. "Bioforce archwires' are one arch wires introduced by GAC. Beginning at approximately 100 grams and increasing to approximately 300 grams, BioForce provides the right force to each tooth, reducing the number of wire changes and providing greater patient comfort. The level of force applied is therefore graded throughout the arch length according to tooth size.

Super-Cable

In 1993, Hanson combined the mechanical advantages of multistranded cables with the material properties of superelastic wires to create a superelastic nickel titanium coaxial wire. This wire, called Superable, comprises seven individual strands that are woven together in a long, gentle spiral to maximize flexibility and minimize force delivery.[17] Supercable wires 0.016" and 0.018" were the only ones that tested at less than 100g of unloading force over a deflection range of 1-3mm. Supercable thus demonstrates optimum orthodontic forces for the periodontium, as described by Reitan and Rygh. Relatively large archwire like 0.18" can be placed at the starting of treatment. When cutting Superable, always use a sharp distal end cutter (No. 619). A dull cutter tends to tear the component wires and thus unravel the wire ends.

Advantages

• Improved treatment efficiency.
• Simplified mechanotherapy.
• Elimination of archwire bending.
• Flexibility and ease of engagement regardless of crowding.
• No evidence of anchorage loss.
• A light, continuous level of force, preventing any adverse response of the supporting periodontium.
• Minimal patient discomfort after initial archwire placement.
• Fewer patient visits, due to longer archwire activation.

Disadvantages

• Tendency of wire ends to fray if not cut with sharp instruments.
• Tendency of archwires to break and unravel in extraction spaces.
• Inability to accommodate bends, steps, or helices.
• Tendency of wire ends to migrate distally and occasionally irritate soft tissues as severely crowded or displaced teeth begin to align.

Optiflex

Optiflex is a non metallic orthodontic arch wire designed by Dr. Talass18 and manufactured by Ormco. It has got unique mechanical properties with a highly esthetic appearance made of clear optical fiber. It comprises of 3 layers:
1) A silicon dioxide core that provides the force for moving tooth.
2) A silicon resin middle layer that protects the core form moisture and adds strength.
3) A strain resistant nylon outer layer that prevents damage to the wire and further increases strength.

Advantages:
1) It is the most esthetic orthodontic arch wire.
2) It is completely stain resistant, and will not stain or lose its clear look even after several weeks in mouth.
3) Its effective in moving teeth using light continuous force.
4) Optiflex is very flexible, it has an extremely wide range of actions, when indicated it can be tied with elastomeric ligatures to severely malaligned teeth without fear of fracturing the arch wire.
5) Due to superior properties optiflex can be used with any bracket system.

Precaution's while using optiflex archwires:
1) Optiflex archwires should be tied into brackets with elastomeric ligatures. Metal ligatures should never be used since they will fracture the glass core.
2) Sharp bends similar to those placed in a metal wire should never be attempted with optiflex, as these bends will immediately fracture the glass core.
3) Using instruments with sharp edges, like the scalers etc should be avoided instead a gentle finger pressure is used to insert the archwire into the slot.
4) To cut the end of the archwire distal to the molar, it is recommended to use the mini distal end cutter which is designed to cut all 3 layer's of optiflex.
5) Optiflex should not be cinched back as a cinch back is actually not needed since friction between elastomeric ligature and the outer surface of the archwire will eliminate unwanted sliding of the archwire.

Optiflex and clinical applications:
1) It is used in adult patients who wish that their braces not be really visible for reasons related to personal concern's or professional consideration.
2) Can be used as initial archwire in cases with moderate amounts of crowding in one or both arches.
3) It should be used in cases to be treated without bicuspid extraction.
4) Opti-flex is not an ideal archwire for major bicuspid retraction.
5) Optiflex can be used in presurgical stages which require orthognathic intervention as a part of the treatment. Optiflex is available in a pack of ten 6 inch straight length wires of .017" and .021" sizes.

Marsenol

Marsenol is a tooth coloured nickel titanium wire. It is an elastomeric poly tetra fluoroethyl emulsion(ETE) coated nickel titanium. It exhibits all the same working characteristics of an uncoated super elastic Nickel titanium wire. The coating adheres, to wire and remains flexible. The wire delivers constant force on long periods of activation and is fracture resistant.

Composite Wires

Manufacturing the composite wire in the photo pulltrusion process[19], fibres are drawn into a chamber where they are uniformly spread, tensioned and coated with the monomer. The wetted surfaces are then reconstituted into a profile of specific dimensions via a die from which they then exit into a curing chamber. As photons of light (ultra violet) polymerize the structure quickly into a composite the morphological features of the vertical processes are revealed. Fibers preferentially reinforce the periphery of the profile and any shrinkage voids are replenished by gravity. If these are the final dimensions of the desired profile, the cure is completed, and the material is taken up on a large spool. If further shaping of size of the profile of the wire the composite is only partially cured, and this is further processed using a second die and staged into the final form.

In the photo pulltrusion process these last 2 stages represent the difference between fabricating circular V/S rectangular profiles, respectively or straight V/S preformed profiles respectively. This system was used to form silicate glass fiber reinforced composites with varying degrees of conversion, by photo pulltruding over a range of pulling speeds.

Composites with matrix solubility's above 10 wt % could be swaged after photopultrusion to change the cross section from circular to rectangular before thermal processing. Circular / rectangular cross section may be varied during manufacturing without any change in wire slot engagement by pulltrusion, in which the relative proportions of the fibers and matrix materials are adjusted approximately and cured by.
electromagnetic radiation. Comparison of composite wire in bending mechanical tests show that wires are elastic until failure occurs. Moreover, when failure finally does occur, the wire loses its stiffness, but it remains intact.

**Combined Wires**

The key to success in a multi attachment straight wire system is to have the ability to use light tipping movements in combination with rigid translation and to be able to vary the location of either, at any time the need arises during treatment. They used three specific combined wires for the technique; Dual Flex-1, Dual Flex-2, and Dual Flex-3 (Lancer Orthodontics)20. The Dual Flex-1 consists of a front section made of 0.016-inch round Titanal and a posterior section made of 0.016-inch round steel. 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.

The Dual Flex-2 consists of a flexible front segment composed of an 0.016’’ 0.022-inch rectangular Titanal and a rigid posterior segment of round 0.018-inch steel. The Dual Flex-3, however, consists of a flexible front part of an 0.017’’ 0.025-inch Titanal rectangular wire and a posterior part of 0.018 square steel wire. The Dual Flex-2 and 3 wires establish anterior anchorage and control molar rotation during the closure of posterior spaces. They also initiate the anterior torque. All wires have elastic hooks.

**Organic Polymer Wire**

Organic polymer retainer wire made from 1.6mm diameter round polythylene terephthalate. This material can be bent with a plier, but will return to its original shape if it is not heat-treated for a few seconds at temperature less than 230°C(melting point). In prefabricating the QCM retainer wires, the anterior portion of the wire and the “wave” portion are heat-treated at about 150°C immediately after bending. Patients who have worn esthetic ceramic or plastic brackets during orthodontic treatment are likely to want esthetic retainers after treatment, so these wires are used for esthetic maxillary retainers. Wire after heat-treated it displayed little deformation. More shrinkage during heating was observed in the posterior segment of the arch wire.

**New Version of Esthetic Retainer (QMC)**

The New esthetics organic polymer is easy to fabricate and fit to the dental arch. It consists :

- Anterior plastic part
- A flat organic polymer wire with 10° labial torque is attached to 0.032” stainless steel posterior arms, each 11cm long. Plastic portion comes in three intercanine widths, with or without activating omega loops in the posterior arms.

There have been efforts to produce esthetic orthodontic wires to complement the ceramic brackets. A transparent non metallic orthodontic archwire with a silica core, a silicon resin middle layer, and a stain resistant outer layer (Optiflex, Ormco) was described by Tallas.

Moreover, when failure finally does occur, the wire loses its stiffness, but it remains intact. Further, when failure finally does occur, the wire loses its stiffness, but it remains intact.

**Future of orthodontic wires**

Kusy21,22 reported that a fluorocarbon-coated, white colored, triple stranded stainless steel wire (Eastman Dental, NJ, USA) does not withstand the mechanical forces and enzyme activity in the oral environment.

Kusy and his colleagues have developed an archwire containing S2 glass fibers (Owens Corning, Toledo O.H, USA) embedded in a polymeric matrix formed from Bis-GMA and TEGDMA, benzoin ethyl ether is present as a UV (Photoinitiator). By adjusting the ceramic / polymer properties, these wires can be manufactured in a wide range of clinically relevant levels of elastic stiffness, using the technique of photopoltrusion with ultra violet light illumination to cure the polymer matrix.

Rectangular cross section and preformed archwires can be fabricated and the surface chemistry can be modified to provide enhanced biocompatibility and low coefficients of sliding friction. Poly (Chloro-P-Xylene) spacers have been found to minimize glass fiber release during manipulation of the wires. This group has also developed a composite ligature wire consisting of ultra high molecular weight poly ethylene fibers in a poly (n-butyl methacrylate) matrix. Watanabe et al have described a polyethylene terephthalate wire for maxillary retainers.

Burstone and Kuhlberg23 have described the clinical application of a new fiber reinforced composite called “Splint-It” which incorporates S2 glass fibers in a bis GMA matrix [7]. This is available in various configurations such as rope, woven strip and unidirectional strip. These materials are only partly polymerized during manufacture (pre-pregs), which makes them flexible, adaptable and easily contourable over the teeth. Later they are completely polymerized and can be bonded directly to teeth. They can be applied for various purposes such as post-treatment retention, as full arches or sectional arches, and to reinforce anchorage by joining teeth together. A particular advantage is that due to direct bondability to teeth, they can obviate the need for brackets in specific situations. In addition, they are highly esthetic, and could thus be an effective alternative to lingual appliances.

**Conclusion**

Fiber reinforced composites are regarded as the last great frontier of orthodontic materials. Due to their excellent esthetics and strength, as well as the ability to customize their properties to the needs of the orthodontist, they are expected to replace metals in orthodontics, just as composites have replaced Aluminum in the aircraft industry. No doubt, these materials promise several exciting new possibilities in biomechanics, and could revolutionize the practice of orthodontics.

**References**
