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Systematic Review on Initial Alignment Efficiency of Coaxial Wire.

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ABSTRACT

The aim of the article is to review the efficiency of coaxial wires in initial alignment of teeth with reference to alignment speed, root resorption and pain intensity. This article also investigates and compares the effects of coaxial wires with other single stranded round , rectangular or square wires used for initial arch alignment. Light and continuous forces are desirable to obtain physiological and controlled movement of teeth. Orthodontic wires used for initial levelling and alignment must be capable of generating such forces and to do so they need to be flexible and must transmit forces in a wide range of activation. Characteristics necessary for a fine clinical performance of a wire during levelling and alignment: low elastic modulus, high resilience, easy engagement into the brackets, flexibility, biocompatibility, low friction coefficient, resistance to corrosion and absence of fracture under orthodontic forces. It is thus important to analyse which orthodontic wire is capable of eliciting the properties without causing complications like root resorption and pain. Use of inappropriate wires can lead to several complications like loss of attachment, rotation or fracture of the tooth, resorption of bone and failure of occlusion. Hence it is necessary to choose the right wire for initial alignment of teeth.

Keywords: Coaxial wires, multistranded wires, archwires, alignment,orthodontics

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INTRODUCTION

Coaxial wire is a six stranded round wire (5 wires wrapped around a single core wire) that is super resilient. It can be bent to a greater degree than conventional rectangular or round wire. Its resilience is most apparent with severely malposed cases. Coaxial wire is a multistranded wire that proved to be highly efficient in arch alignment during 1960 -1990.

Multistranded arch wires are made up of a number of thinner wires wounded together. They can be twisted (triple stranded), coaxial (six stranded) or straight woven (eight stranded, rectangular and braided). Multistranded wires show high flexibility over other wires. Due to the gentle nature of the force delivered multistranded wires are traditionally used in initial stages of orthodontic treatment to correct maligned teeth. Multistranded wires apply low force over a given span with minor to moderate deformation depending on the severity of the malocclusion. Each strand of the multistranded wire is made by reducing the metal into round strands of the desired diameter by repeatedly drawing through progressively smaller dies, or traditionally through holes in draw plates. After a number of passes, the wire may be annealed to facilitate more drawing .The heated wires are then wound over each other. It is then annealed again to increase the ductility. Coaxial wires are made up of stainless steel or nickel titanium. One can employ coaxial wires for initial stage of tooth alignment and levelling without the need for loops.

Classification of multistranded wire:

A variety of multistranded wires are used in orthodontic treatment, each of which has different properties to suite its purpose. So the types of multistranded wires are as follows :[1]

According to American orthodontics ,Multistranded wire are further classified into

- Twist (triple stranded)
- Coax (five stranded)
- straight woven (eight stranded)

According to dentaurum they are classified into:

- Dentaflex (triple stranded)
- Coaxial (six stranded)
- Eight stranded

Functionally orthodontic wires are classified into rigid (mostly stainless steel wires used for retraction) and flexible wires (used for aligning). Coaxial wires are flexible wires commonly used in initial alignment of teeth.

Properties

These wires have low stiffness which allows easy bracket engagement without the wire taking a permanent set. The average (measured for 15.5, 19.5, 21.5 mm diameter) stiffness value for coax wire is 0.53.[2] It also has a wide working range which provides the ability to move teeth without undue discomfort to patient. The mean value of tooth movement for coaxial wire at 4, 6, 8, 12 weeks are 1.552, 2.327, 3.103, 9.87mm respectively. [6]Due to the large diameter of the wire it can be used earlier in treatment to achieve control.

The wire doesn't fray when cut because it has five wires wound over a central wire. It was found that at 4.2 mm of deflection, there was permanent plastic deformation of the coaxial wire. [4] The coaxial wire has a low mean deactivation force of 1.94 N.[3] According to a recent study a force of 16 N is required to separate the bonded wire from tooth. The ratio of 1% Yield Strength to Ultimate tensile Strength averaged 0.88 for the coax wires. The average (measured for 15.5,19.5, 21.5 mm diameter)strength value for coaxial wire was found to be 0.18 and the yield strength values averaged 1.78 GPa .[9]Range of activation averaged 0.35 for coax wires (measured for 15.5,19.5, 21.5 mm diameter). [9]Modulus of elasticity of coaxial wire is $1.25*10^6$ psi

Thus the above important features makes coaxial wire the wire of choice for initial levelling and aligning where teeth are severely malposed.

Review of literature

Cátia Cardoso Abdo Quintão et al, in her research, compared stainless steel wire with coaxial wire and concluded that the elastic recovery of coaxial wire is 25% higher than stainless steel wire of identical diameter. Also when comparing conventional stainless steel wires with multi-stranded wires of similar diameter the latter have one fifth the modulus of elasticity of the former, and an activation range 150 to 200 times greater than the former. Stainless steel multi-stranded wires share some mechanical properties with nickel-titanium alloys. However, their low elastic limit makes them susceptible to plastic deformation by external forces, such as chewing. When subjected to identical stress these wires exhibit a much higher degree of permanent deformation than nickel-titanium. With the purpose of saving chair time professionals often neglect to contour multi-stranded arch wires according to intercanine and intermolar widths as well as the shape and width of the patient's arch. Although less formable than conventional steel wires multi-stranded wires are responsive to contours and bends, such as omega loops for posterior tying, thus preventing tooth projection. Also in another study comparing coaxial , con entail and NiTi wires the multistranded stainless steel wire had the lowest mean deactivation force (1.94 N), while the conventional stainless steel group had the highest value (4.70 N). The superelastic and thermoactivated Ni-Ti groups were similar to the multistranded wire ($P > .05$) [9]

According to Nagalakshmi et al, who compared Optiflex wires with coaxial wires, Optiflex had a low load-deflection when compared to coaxial wire. Clinically, Optiflex and coaxial wire had similar decrowding efficiency. In both, study model and cephalometric analysis, there was no statistically significant value when comparing their mean variables. Coaxial arch wire has a central core for stability with outer wires wrapped around for resilience and flexibility. At 4.2 mm. of deflection, there was a permanent deformation of coaxial wire which is almost similar to Optiflex wire which has a permanent deformation at 4.06 mm of deflection. Coaxial wires are cheaper when compared to Optiflex wires. The invitro study revealed that Optiflex had a low load-deflection when compared with the coaxial wire. It reaches its proportional limit much earlier, whereas coaxial showed a steady deformation rate during the loading process. In the in vivo study, when the means of arch length of the 45th day values for Coaxial and Optiflex wire were compared, there was a decrease in arch length in both groups, but the decrease in arch length in Optiflex is less than that of Coaxial. [4]

In a recent study done by Biju Sebastian et al, it was revealed that Coax NiTi wire is better in incisal alignment than coaxial stainless steel wire.[5]

Satpal Singh Sandhu et al, investigated pain associated with superelastic nickel–titanium and coaxial stainless steel archwires during the initial levelling and aligning phase of orthodontic treatment and concluded that pain in subjects with superelastic nickel–titanium archwires was significantly greater than coaxial wire at 12 h, as well as at day 1 in the morning , afternoon and at bedtime .[6]

According to Marco Abdo Gravina, the coaxial wires demonstrated a significant greater aligning capacity in comparison to the stainless steel wires. [7]

Asli Baysal et al, recommends coaxial wires as an initial arch wire because it applies lighter and gentler forces yet lesser load deflection than dead soft wires. The researcher also states that this wire is very flexible and possesses great spring-back characteristics. [8]

Brian K. Rucker states that compared to the elastic properties of the conventional NiTi wires, coax stainless steel wires generally matched the stiffness, but had only one-third to one-half of the strength and range.[9]

Advantages

The wire is cheaper than most wires. It also has a wide activation range. When compared with other wires it causes lesser pain during treatment. This is due to its low mean deactivation force. It also has low stiffness as mentioned above and yet has low load deflection. Coaxial wires are weldable and have a high

degree of flexibility .The property of resilience makes it apt for alignment of severely malposed teeth. The dentist has an increased level of uprighting, levelling and rotational control over the wire. Most dentists prefer Coaxial NiTi wire as it delivers low force at initial stages which increases at a steady rate with time. Also coaxial wires have a high mean resistance to displacement from composite

Disadvantage

The disadvantage is that it is less formable. They also develop higher friction at bracket-wire interface compared to NiTi wires. These wire like most other wires are non-aesthetic (except Optiflex wires). The clinicians also feel a certain degree of difficulty to engage the wire into the bracket. The low elastic limit of the wire makes it susceptible to plastic deformation .The wire also has a high yield strength.

Conclusion

The multistranded or coaxial NiTi wires exhibit most desired properties of an initial arch wire. Hence it should be the first choice of wire during the initial stages of treatment followed by thermal NiTi and superelastic NiTi. Multistranded stainless steel wires can also be considered as an economical alternative to more expensive NiTi wires.

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