GAC White Paper Report

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Making a Good Use of a Good Material: BioForce® Arch Wires

Dr. Mladen M. Kuftinec, StomD, DMD, ScD

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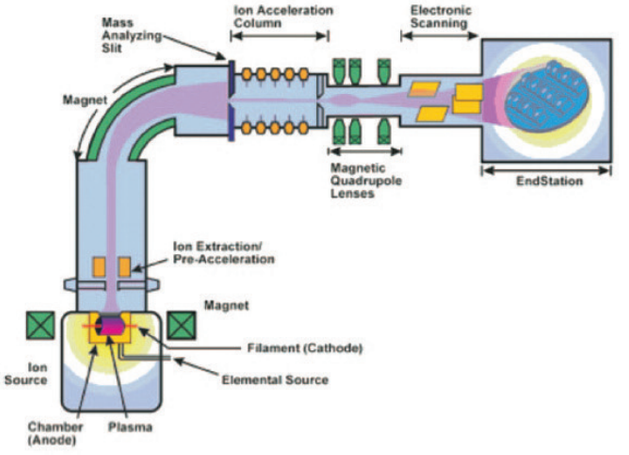
Making a Good Use of a Good Material: BioForce® Arch Wires

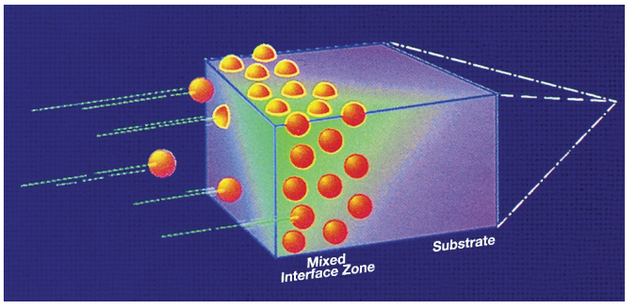
Introduction

This section will describe and illustrate appropriate uses of an outstanding orthodontic product: BioForce arch wire. A BioForce wire is a superelastic shape memory Nickel Titanium wire that provides gradually increasing forces from anterior to posterior segment, all within one arch wire. Therefore, BioForce wire can be deflected or activated in such a way that it will produce significantly lower forces when deflecting it in the area that engages relatively small anterior teeth, while it will gradually increase the force moving from the anterior to the posterior segment of the wire.

Archwire Evolution

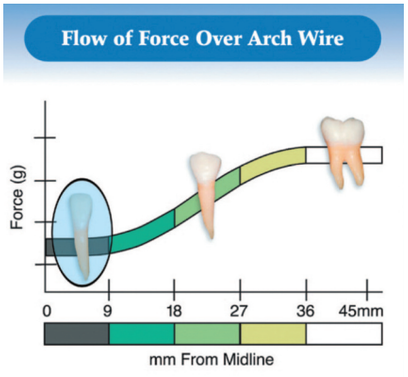
Since the introduction of Nickel Titanium alloys for fabrication of orthodontic arch wires in 1970's, orthodontic arch wires have become more complex and suitable for a variety of intricate clinical uses, primarily due to their great flexibility and memory retention. In fact, the race for development of the best wire created an overabundance of what was labeled the "smart arch wires". The differences between various products, manufactured by numerous metallurgic laboratories statewide and abroad, were not significant. In certain cases the alloy was augmented by small amounts of copper [Cu], zinc [Zn] and noble elements [Pd, Ar]. The chief difference, however, has been how the alloy was processed or, more specifically, what stages of heating and cooling were utilized in manufacturing of the finished wires. All these wires showed an increased elasticity and were labeled as 'superelastic', lighter-force delivery for a given deflection and an excellent ability to retain their initial memory. This means that no matter how severely they were deflected, they would repeatedly spring back into their initial passive position or configuration. One negative aspect of these wires included their increased surface roughness, which typically increased sliding friction. For BioForce this concern is addressed with an ionization implanting process utilized to alter the surface of the arch wire without negatively affecting the wire's unique superelastic properties. During the ion beam implantation process, Nitrogen replaces Nickel on the top and changes the surface to Titanium Nitride. BioForce wires with IonGuard® result in a significant reduction in friction during tooth movement.

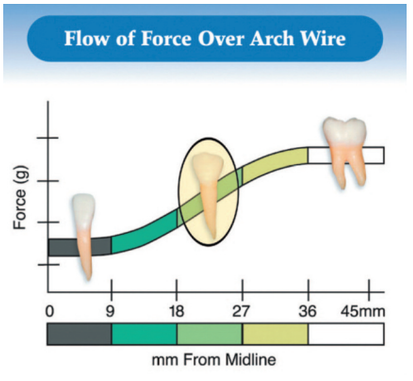


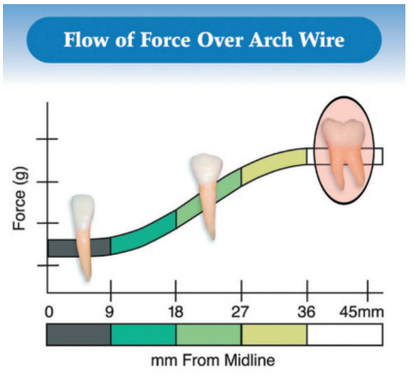


What Makes BioForce Different?

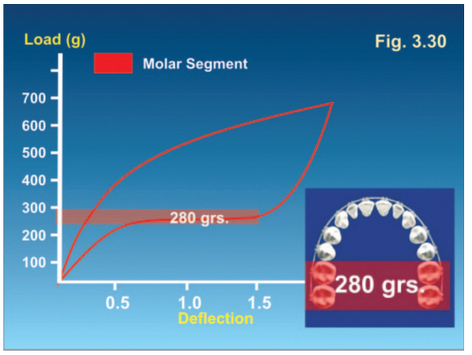
One of the chief characteristics of these superelastic wires is delivery of very light forces for a typical degree of wire deflection. Practically speaking, they may deliver the desirable force levels for the relatively small, single rooted teeth, particularly incisors. The force may not be adequate to either move, or to prevent an uncontrolled movement of larger teeth, particularly molars. One can easily conclude that it would be desirable to develop an arch wire that can produce low level of force for a given deflection [or activation] in its anterior segment, then progressively increase that level of delivered force toward its posterior end, the part that is usually inserted into the molar tubes.

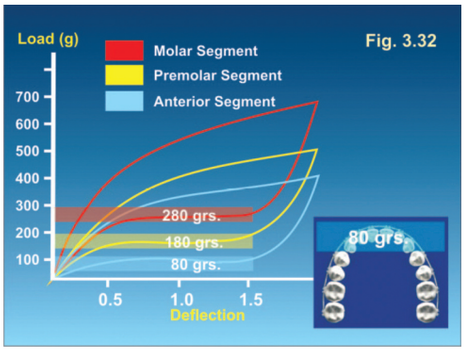


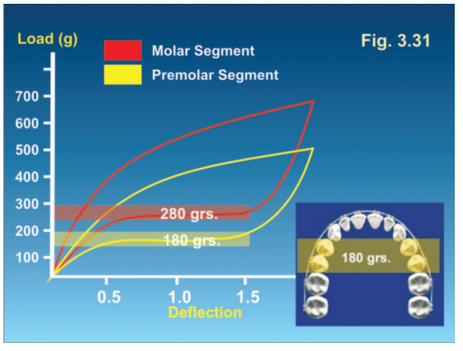




This is precisely why the BioForce arch wires were created. The concept was first described by Dr. Miura of Japan. His idea was that if one starts with a "cold alloy" and then heat treats it under controlled conditions, the stiffness of the resulting arch wire will be related to the length of its heat treatment. A classical example was offered by Miura, in which an arch wire was not heat treated in its most posterior parts, but progressively heat treated for longer periods of time as it approached its anterior segment. It was experimentally determined that progressive time increments of 15 minutes worked the best for a typical BioForce arch wire.

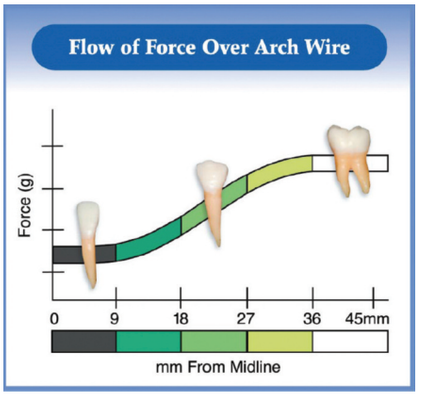






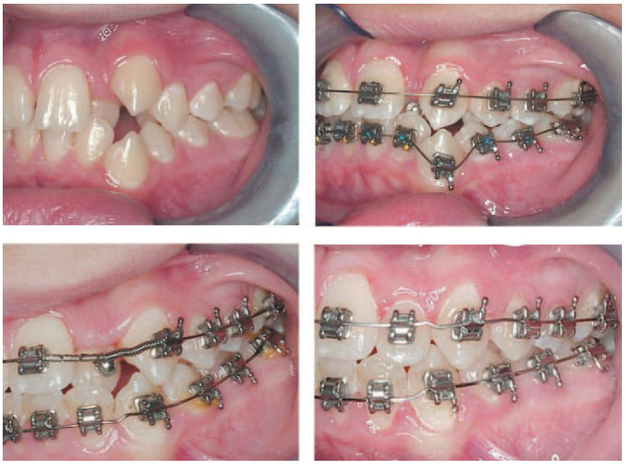
The force delivery is affected by numerous factors: the cross-sectional dimension of the wire, the inter-bracket distance [or the length of the lever], special orientation of adjacent teeth, among others. Let us standardize geometry of the dental arch and assume that we use a moderately heavy arch wire, for instance a 0.016 X 0.022". While the BioForce is capable of providing the forces specified above, a typical activation of 1 mm produces approximately 28g of force in the incisor area, 55g in the canine-first premolar area, and approximately 85g in the first and second molar area.

It takes less than 30g [or about 1 oz] of force to effect most movements of incisors. Conversely, these characteristics can be viewed such that in the posterior segment the BioForce arch wire provides close to 100g of anchorage value against most displacements of molars. It is difficult to design a biologically better system of forces than this! Of course there are factors other than the composition and characteristics of an arch wire that determine if and how teeth move, but the arch wire is an important component of this complex formula.



Clinical Treatment Applications

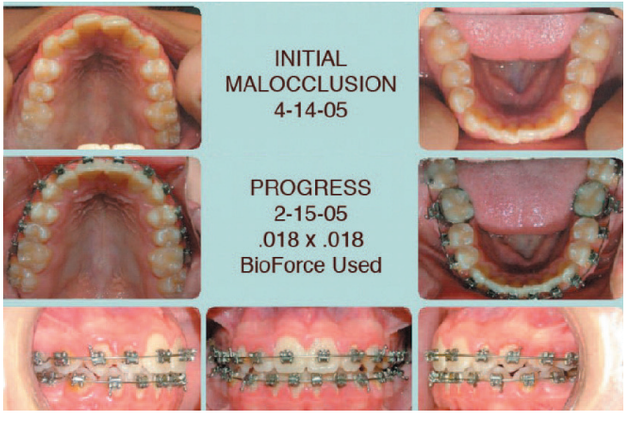
Let us next look into some of the clinical situations or treatment stages where the BioForce arch wire may be a particularly useful tool. Generally speaking, most clinicians tend to start the treatment by inserting a small diameter flexible round arch wire, e.g. 0.014" Sentalloy. With interactive self-ligating brackets, such as In-Ovation® R, this wire will usually create very desirable micro-movements of dentition. Misaligned teeth will start moving into better position. Those movements will be limited by this wire's ability to deliver continuous forces adequate to affect the biological response needed to remodel the alveolar socket. At that point the clinician now has several choices. He could increase the size of the superelastic arch wire, or he can change to a different alloy composition wire. For instance, if at this time he wants to affect the shape of the dental arch or the depth of the Curve of Spee, the use of BioForce may be his best choice.



Another typical use of BioForce arch wire is in later stages of treatment, when we are attempting a particular treatment step or procedure for a prolonged period of time. For instance, the posterior occlusion is not settled in, rotations have not been fully corrected or the bite opening is taking a long time because of the heavy musculature. These are all good reasons to place a BioForce arch wire and allow the occlusion to settle, while the undesirable effects of the applied force-producing mechanisms will be minimized.

Some practitioners like to use BioForce arch wires early on in treatment for cases in which significant anterior torque is needed. In these cases one can start using a relatively large size BioForce arch wire, for instance 0.018 X 0.025", without the fear that its use will cause significant root resorption.

A bit less common (and possibly viewed as unorthodox use, but nevertheless interesting to mention) is the application of a medium size BioForce, perhaps 0.018 X 0.018" or 0.016 X 0.022" at the very start of treatment of relatively mild cases, then leaving it in place for several months. In a few such cases, provided that the attachments were placed correctly, we observed a complete resolution of the malocclusion, nearly to the point of not needing any additional arch wires or additional treatment.



Summary

In summary, it can be stated that BioForce arch wires have the unique property of delivering remarkably accurate and biologically correct forces, to optimally move the teeth of different parts of the dental arch. Together with the interactive self-ligating brackets (such as In-Ovation R or its ceramic version, In-Ovation C), these wires are capable of consistently producing excellent treatment results without causing many of the undesirable effects commonly encountered with the use of other arch wire materials. BioForce is a high-tech product capable of achieving excellent clinical results.

References

Dr. Mladen M. Kuftinec, StomD, DMD, ScD

During his career Dr. Mladen Kuftinec has distinguished himself as an orthodontist, physician and scientist. Dr. Kuftinec graduated from medical school in the former federal republic of Yugoslavia, and received his Certificate of Orthodontics and DMD degrees from Harvard University. He also holds a Doctorate of Sciences in Nutritional Biochemistry degree from the Massachusetts Institute of Technology. Dr. Kuftinec served as the Chairman of the Orthodontic Department at NYU from 1990-1997, Director of the Post-Graduate Orthodontic Program until 2000, and has since been Director of NYU's International Orthodontic Program. The author of more than 200 published articles and abstracts, Dr Kuftinec has made contributions to several books, including the recently published *Excellence and Efficiency of Interactive Self-Ligation*.